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PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

a quarterly report

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Soil and Water Conservation Research Branch
Agricultural Research Service
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The Branch will publish the results of experiments reported here as promptly as possible. Some of the results carried in these quarterly reports are simultaneously in the process of publication.

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The Soil and Water Conservation Research Branch works in cooperation with the State Agricultural Experiment Stations.

CONTENTS

IRRIGATION

North Carolina

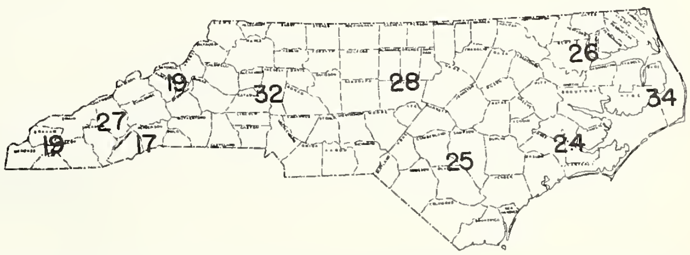
SURVEY OF DROUGHT CHANCES UNDER WAY IN FOUR-STATE AREA

C. H. M. van Bavel, Raleigh. --It has long been recognized that severe summer droughts can occur in the East and that irrigation will often pay handsomely. But there is a recent increase in supplemental irrigation which requires a more precise knowledge of the chances for drought and of the amounts of water that are needed to combat lack of soil moisture.

A new project, to chart the probabilities for drought in the entire Eastern half of the country, has been under way for a year. In this study the varying water storage capacity of soils is taken into account, as well as the amount and the distribution of rains and the rate of evapotranspiration losses (consumptive use).

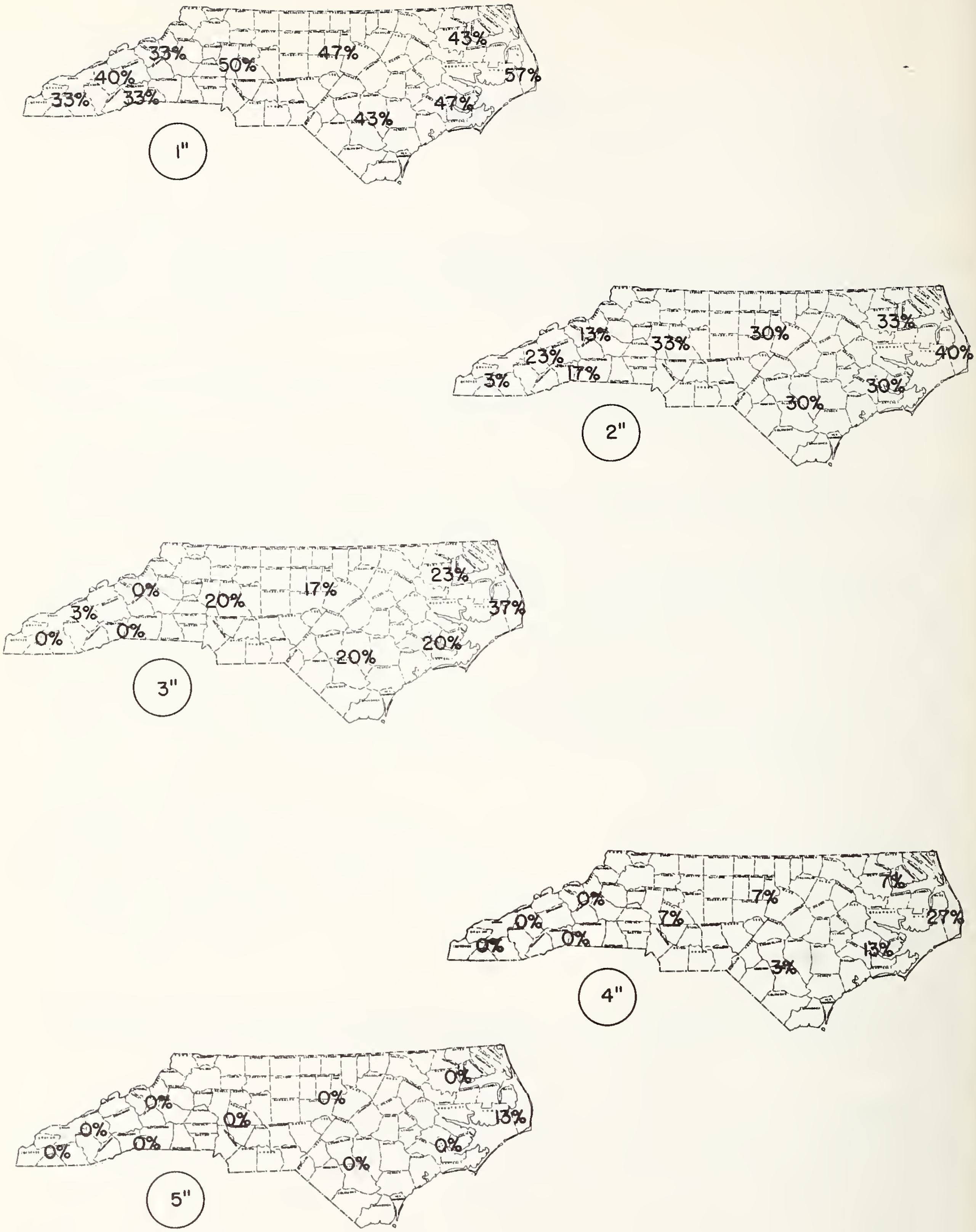
Recently, arrangements have been made to make a full-scale investigation of conditions in the states of Virginia, North Carolina, South Carolina, and Georgia, possibly supplemented with Florida. This work is now in progress in cooperation with the various Agricultural Experiment Stations and the United States Weather Bureau.

Example of drought occurrence. Actually, the work for North Carolina has already been finished as a pilot project, and it will soon be published in a Technical Bulletin. Therefore, we can show a few examples of the kind of information that will eventually be available for the other states as well. First of all, there will be charts and maps which show on how many days during any period of the growing season the supply of readily available soil moisture is exhausted. For example, in Figure 1 we see the minimum number of drought-days which can be expected during June and July in 2 out of 10 years. These figures are based on the assumption that the root zone can store 2 inches of moisture in available form. No attempt is made here to define "available moisture" since this procedure works equally well for any definition, and limits of moisture availability and rooting depth must be determined in other studies. For different times of the year and for different odds, as well as different soil conditions, another picture is obtained each time. When fully available, these data will point up to the reader the seriousness of the drought situation and also the marked influence of soil moisture holding properties.



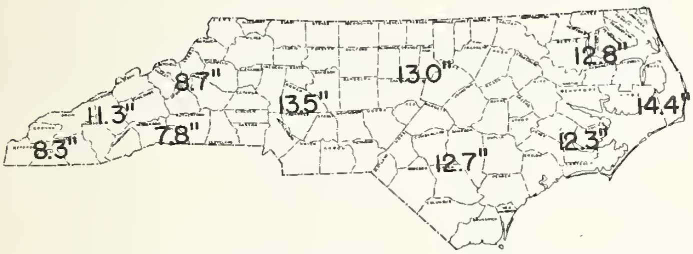
Minimum number of drought days to be expected in June & July in 2 out of 10 years, assuming 2 inches of soil moisture storage in root zone.

Influence of soil properties on drought occurrence. Another illustration, perhaps more dramatic, is given in Figure 2. It gives the probability that any day in June will be a drought-day, assuming that the root zone can hold no more than 1 inch of available soil moisture. In other words, in that situation odds are about 1 out of 2 in central North Carolina that a day will be one in which irrigation would be needed (see upper left map in Figure 2). This same information is given in Figure 2 for other amounts of the maximum available water in the soil. It should be obvious how highly important it is to obtain a good estimate of this figure in a practical case.



Probability of any day in June being a drought day, assuming fine soil moisture storage capacities, as indicated.

Estimating safe size of water supplies. The success of irrigation depends upon adequate water supplies. Accurate estimates of the water requirements are needed. The drought studies can provide these figures to design engineers. For example, if an irrigation system is to be used throughout the growing season and if the soil can contain no more than 2 inches of available water, we arrive at the requirements shown in Figure 3. These are sufficient to meet the demand in 9 out of 10 years, and similar charts can be prepared to show, for example, the demand for 5 out of 10 years. The figures shown are not corrected for efficiency of distribution. Assuming that efficiency is 80% and that 15 acres have to be irrigated, the maximum load on the water supply will be close to 20 acre-feet in central North Carolina if the demand for 9 out of 10 years is to be met. This is a starting figure for the design or selection of the source of water.



The amount of irrigation water that will be sufficient in 9 out of 10 years. The soil moisture storage capacity is assumed to be 2 inches.

This project draws entirely from existing data. But, simultaneously, intensive studies are being made of evapotranspiration and the factors that influence it as well as of crop response under different levels of soil moisture, in order to improve, in the future, our estimates of drought occurrence and the need for irrigation.

Nebraska

EARLY AND LATE IRRIGATIONS IMPAIR QUALITY OF BEANS

O. W. Howe, Mitchell.--One of the objectives of this project at the Scotts Bluff Experiment Station is to determine the effect of time of irrigation upon the development of disease in Great Northern field beans.

In one test (1954) a late August irrigation, applied as the first pods began to mature, increased the percentage of discolored beans and did not appreciably increase yield. The first irrigation of the season apparently increased the percentage of discolored beans but also increased yield an average of four bushels per acre.

Percent of beans discolored by disease (bacterial wilt and blight) was determined for each of 25 irrigation treatments in an experiment on Tripp very fine sandy loam. In the accompanying table, the treatments are listed in the order of increasing percentage of discolored beans. The dates irrigations were applied and the yields are shown for each treatment.

The nine treatments that received the August 25 irrigation had the highest percentage of discolored beans, showing that in this test late irrigation caused deterioration in quality due to disease. When only treatments that did not include the August 25 irrigation (all treatments listed above Treatment 14) are considered, the table shows that plots that received the first irrigation (July 8) produced more discolored beans than plots that did not receive the first irrigation. Unlike the late August irrigation the first irrigation of the season was of definite value in increasing yields. Irrigations applied on any or all of the intermediate irrigation dates--July 18, July 29 and August 5--do not appear to have affected quality of the beans.

Percentages of discolored beans (Great Northern field beans) associated with various irrigation treatments, Scotts Bluff Experiment Station, Mitchell, Neb., 1954

Treatment number	Discolored beans	Yield per acre	Irrigation Dates				
			July			August	
			8	18	29	5	25
	Percent	*Bushels*					
7................	1.6	33.0			X		
24...............	1.7	36.1		X	X		
10...............	1.8	36.5		X			
5................	2.2	39.7	X	X			
21...............	2.4	40.6		X	X	X	
19...............	2.8	26.9					
17...............	2.8	34.8		X		X	
23...............	2.8	35.7			X	X	
20...............	2.8	43.5	X		X	X	
18...............	3.1	34.6	X				
12...............	3.1	38.4	X			X	
4................	3.2	39.3	X		X		
16.3.............	3.4,3.6	44.1	X	X	X	X	
9................	3.6	33.5				X	
13...............	3.6	35.7	X	X		X	
14...............	3.6	37.8	X	X		X	X
22...............	4.0	39.5		X	X	X	X
2................	4.0	44.1	X	X	X		X
1................	4.1	32.6				X	X
25...............	4.2	36.9			X		X
11...............	4.3	41.2			X	X	X
8................	4.6	40.1	X		X		X
15...............	5.3	43.3	X	X	X	X	X
6................	5.4	43.8	X		X	X	X

Colorado

PONDING, METERING METHODS OF MEASURING CANAL SEEPAGE DESCRIBED

A. R. Robinson and Carl Rohwer, Fort Collins.--Ponding or tappoon method. The most accurate means of measuring seepage losses from irrigation channels is the ponding or tappoon method. This method requires the construction of earth dykes or timber bulkheads at each end of the test section. Water can either be pumped into the section or allowed to flow in by gravity through a gate in the upper bulkhead. This gate is closed after the section is filled to isolate the section. By measuring the rate of drop of the water surface, the seepage loss in the section can be accurately determined. The length of the section, the average width of the water surface, and the wetted perimeter must be determined to convert the seepage to a unit rate. In many instances, however, it is impossible to use this method since the canal must be taken out of operation for the period of the tests. The tests can be run before or after the irrigation season, but in these cases the tests must be run for a longer period in order to allow the soil to become primed.

Current meter measurements. Inflow-outflow measurements with current meters can be made with reasonable accuracy if proper care is taken in making the measurements. Long reaches of canal (in the neighborhood of four to five miles) are desirable. Current meter measuring stations should have uniform sections and be selected so that several hundred feet of straight section exists before the measuring section. In many

cases, measuring stations in rectangular concrete sections are available and should be used since more accurate measurements can be made in these sections. Velocities should range between 2 and 5 feet per second. It is necessary to install a water stage recorder so that the measurements can be made after a constant stage has existed in the canal for several hours. All turnouts and diversion from the section must be measured by installing weirs if permanent measuring devices are not in place. The length of section and the wetted perimeter should be determined.

A paper entitled "Measurement of Canal Seepage", Separate No. 728, June 1955, has been published by the American Society of Civil Engineers. This paper gives a summary of the results of special seepage studies.

Colorado

PORTABLE MEASURING DEVICE SOUGHT FOR SMALL FARM CANALS

A. R. Robinson, Fort Collins.--In Arizona, New Mexico, and Texas there are many miles of small farm canals and laterals of the slip or Fuller form types. These ditches are concrete lined and have uniform trapezoidal cross-sections. There is need for a portable device for use by technicians of the ARS and SCS as well as farmers in measuring discharges.

A new project is being initiated to develop a device for making quick and reasonably accurate measurements in these canals. A preliminary study indicates that a modified Pitot tube device may be developed to solve this problem. This device will be given preliminary tests in the hydraulics laboratory and if feasible will be tested in the field. Other methods will also be tested.

California

"SEEPOMETER" BEING DEVELOPED FOR USE IN CANAL BANKS

Leonard Schiff, Bakersfield.--A pit about 2 feet square and 2 1/2 feet deep was dug into the lower bank of the Outside Canal. This pit was located above the toe of the bank but below the hydraulic gradient established by the water in the canal. Aninfiltrometer was injected at right angles into the canal side of the pit for use as a "seepometer." The quantity of water flowing through the infiltrometer into a container in a given period was measured.

An improved "seepometer" is planned. The aim is to have it operate with a rising water table in the pit and not require bailing.

California

PEA GRAVEL SURFACE LAYER INCREASES INFILTRATION RATES

Leonard Schiff, Bakersfield.--Recent observation of water spreading areas in California shows rapid infiltration rates obtained on recharge basins, pits and canals where coarse gravel was used as a surface layer. Sand, in comparison, appears to be too effective a filter with water borne silt being filtered out in a thin plane near the sand surface.

Infiltration rates of the one-seventh acre Peoria infiltration pit increased from an average of three to nine acre-feet per day when the surface sand layer was replaced with a 6-inch pea gravel layer. An average of 9acre-feet infiltration per day was maintained for a period of 5 1/2 months.

TEST OF "INJECTION WATER SPREADING" IS ENCOURAGING

Eldred S. Bliss, Bakersfield.--Further studies are under way to determine the cause of the unsatisfactory performance of experimental gravel filled shafts as a means of infiltrating water into underground aquifers. These shafts are thought to have greatest promise where aquifers are overlain with relatively impervious soil strata.

The gravel was partially removed from one shaft to expose a shallow, sandy aquifer at a depth of 5 to 7 1/2 feet. A fine film less than 1/16 inch in thickness was found covering the entire aquifer face. Two to three inches of material from the aquifer face was removed, and the shaft was again carefully filled with gravel. Functioning of the shaft below a depth of eight feet was only partially eliminated by placing a six-inch clay pad at this depth. The intake rate started at 0.15 acre-foot per day and slowly but steadily increased to 0.19 acre-foot per day. On two previous tests of the full depth of this shaft, intake rates reached a peak in 10 days and then declined to 50% of the peak by the end of 30 days of operation.

Another experimental infiltration pond is equipped with two shafts now in operation. More extensive aquifer layers are intersected by these shafts and considerably higher intake rates are attained than with other shafts being tested. These rates have remained relatively high for over 60 days although decline is in evidence.

Intake rates for two shafts in Pond 26

North shaft		South shaft		Remarks
Day of run	Intake rate per day	Intake rate per day	Day of run	
	Acre-Feet	*Acre-Feet*		
1............	0.88	Not operating		
5............	.65			
10............	.58			
15............	.65			
15............	.35	0.47	1	
20............	.42	.45	5	
30............	.37	.48	15	North shaft redeveloped by
35............	Down	.75	20	pumping on 33rd day. Restart
40............	.40	.35	25	37th day.
50............	.41	.33	35	
60............	.45	.30	45	Meter failure from day 65
95............	.31	.30	80	to 95.

A preliminary attempt to "redevelop" one of the shafts by pumping a 2" well point driven to near the bottom of the gravel filled shaft only slightly improved the declining intake rate.

It is apparent that the satisfactory performance of "injection water spreading" type shafts depends upon (a) the attainment of rather high intake rates, (b) the maintenance of these rates during the season water is available for recharge use, and (c) their capability of repeating this performance in subsequent seasons.

USE OF WATER IN LAKE COUNTY IS SUBJECT TO STATE REPORT

Harry F. Blaney.--Information in this report is being contributed to a study carried on in cooperation with the Division of Water Resources, State of California and the Soil Conservation Service involving the whole subject of the utilization of water supply of the Scotts Valley-Upper Lake and the Big Valley Soil Conservation Districts.

A cultural survey showed 8,008 acres of irrigated land and 16,663 acres of dry-farmed crops. Irrigation practices varied considerably depending on the kind of crop and depth to water table. Soil moisture studies indicated irrigation efficiencies ranged from 40 to 65 percent for pears, 60 to 70 percent for walnuts, 45 to 80 percent for permanent pasture, and 35 to 80 percent for alfalfa. The average for 46 fields was 55 percent.

Determinations of normal rates of water consumption based on soil moisture studies and climatological data are shown in the following tabulation:

Classification or crop	Consumptive use of water in--					
	Scotts Valley-Upper Lake Soil Conservation District			Big Valley Soil Conservation District		
	Oct. 1 to Mar. 31	Apr. 1 to Sept. 30	Annual	Oct. 1 to Mar. 31	April 1 to Sept. 30	Annual
Irrigated Crops	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Alfalfa....................	1.00	2.48	3.48	1.00	2.53	3.53
Beans......................	.50	.94	1.44	.50	.95	1.45
Corn.......................	.50	1.55	2.05	.50	1.58	2.08
Grain (spring).............	.50	1.02	1.52	.50	1.02	1.52
Hops.......................	.50	2.18	2.68	.50	2.22	2.72
Pasture....................	1.00	2.48	3.48	1.00	2.53	3.53
Pears......................	.50	1.87	2.37	.50	1.90	2.40
Prunes.....................	.50	1.87	2.37	.50	1.90	2.40
Truck......................	.50	.87	1.37	.50	.88	1.38
Walnuts (young)............	.50	1.87	2.37	.50	1.90	2.40
Walnuts....................	.50	2.18	2.68	.50	2.22	2.72
Vineyard...................	.50	1.58	2.08	.50	1.62	2.12
Dry-farmed crops						
Pasture and orchards.......	--------	--------	1.75	--------	--------	1.50
Other crops................	--------	--------	1.50	--------	--------	1.25
Native vegetation[1]						
Swamp (tules)..............	0.48	3.57	4.05	0.48	3.61	4.09
Trees-brush (heavy)........	--------	--------	4.87	--------	--------	4.90
Grass-brush (medium).......	--------	--------	3.41	--------	--------	3.43
Miscellaneous areas						
Town-farm lots-cemeteries..	0.6	1.4	2.0	0.6	1.4	2.0
Water surface..............	.5	2.5	3.0	.5	2.5	3.0
Waste land.................	--------	--------	1.0	--------	--------	1.0

[1] In areas of high water table.

This information will be published as an appendix to a report being printed by the State on "Lake County Investigations" and reprints will be available at an early date.

California

BULLETIN ON COST OF IRRIGATION WATER BEING REVISED

Harry F. Blaney, Los Angeles.--"Cost of Irrigation Water in California" (Bulletin No. 36) by Harry F. Blaney and Martin R. Huberty, published in 1930 by the State, is being revised in cooperation with the California State Division of Water Resources and the University of California at Los Angeles. Collection of data on water supply, amount of water delivered to farms, area irrigated, and cost of water for irrigation districts, mutual water companies, and public utilities has been started. Gilbert L. Corey and Professor Huberty are assisting on this work.

California

EVAPORATION, EVAPO-TRANSPIRATION DATA FOR BAY AREA REPORTED

Harry F. Blaney, Los Angeles, and Dean C. Muckel, Berkeley.--A paper entitled "Evaporation and Evapo-transpiration Investigations in the San Francisco Area" by Harry F. Blaney and Dean C. Muckel has been revised for publication by the American Geophysical Union. This paper presents the results of studies during 1953 and 1954 to determine probable evaporation and evapo-transpiration losses that would occur if barriers were constructed across the San Francisco Bay to exclude salt water. Measured evaporation and consumptive use data were correlated with climatological records and estimates made of monthly and annual rates of water consumption from lake surfaces and marsh lands for critical years and for the average period 1921-1952. Examples of results are shown in the following table for Newark, for the 1921-52 period:

Month	Evaporation (lake)	Evapo-transpiration by:			
		Tules (Water table at surface)	Saltgrass where depth to water table is--		
			2 feet	3 feet	5 feet
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
Jan.............	0.82	1.47	1.96	1.80	1.47
Feb.............	1.39	1.74	2.08	1.91	1.91
Mar.............	2.47	2.92	2.92	2.69	2.47
Apr.............	3.76	4.51	3.26	3.01	2.50
May.............	5.00	6.77	3.83	2.36	2.06
June............	6.20	7.13	4.03	2.17	1.86
July............	6.46	8.08	4.20	2.26	1.94
Aug.............	5.74	6.95	3.93	2.11	1.81
Sept............	4.30	6.18	3.49	1.88	1.61
Oct.............	3.30	4.71	3.06	1.88	1.88
Nov.............	1.49	2.98	2.42	2.05	2.05
Dec.............	.83	1.66	1.66	1.66	1.66
Annual..........	41.76	55.10	36.84	25.78	23.22

California

FIVE-YEAR STUDY OF WATER LOSSES INAUGURATED

Dean C. Muckel, Berkeley.--A five-year study of evaporation and consumptive use losses has been started in the San Francisco Bay and Delta areas, in cooperation with the Corps of Engineers, U. S. Army.

Eight evaporation stations are in operation at selected points within the area. Consumptive use of phreatophytes (tules) is being measured at one point and atmometers are installed to establish the relationship with evaporation and consumptive use.

PERMEABILITY OF SURFACE SOIL AND SUBSTRATA VARIES WIDELY

V. S. Aronovici, Pomona.--Two ring infiltrometers were placed at ground surface and two others in pits on the soil substratum at three avocado orchard sites in San Diego County, California. Most of the surface soil there is a loam to a sandy loam with a relatively high infiltration capacity on moderately to steeply rolling topography.

The object was to compare the infiltration rate of the surface soil with that of the substrata. The table that follows summarizes the results of the field study:

Infiltration observed on surface and substrata of representative soils, Escondido Soil Conservation District, California

Soil series	Infiltration rates in double rings				
	Elapse time	Surface soil		Substrata	
		Ring 1	Ring 2	Ring 1	Ring 2
	Hours	*Inches*	*Inches*	*Inches*	*Inches*
Vista sandy loam[1]......	1	8.2	10.8	3.3	4.2
	2	14.6	17.1	4.6	10.2
	3	22.1	23.2	5.3	12.7
	4	28.5	28.5	6.0	14.1
	5	32.9	32.1	6.4	14.8
	Average infiltration velocity for five-hour period, ins/hr	6.58	6.42	1.28	2.96
Fallbrook sandy loam[2]..	1	3.2	4.9	0.9	4.8
	2	6.3	9.5	.9	8.2
	3	8.4	13.5	1.2	11.2
	4	10.4	16.2	2.5	13.5
	5	12.5	17.5	3.0	15.0
	Average infiltration velocity for five-hour period, ins/hr.	2.5	3.5	.6	3.0
Escondido loam[3]........	1	3.7	1.3	0.6	0.3
	2	4.4	2.2	.9	.5
	3	5.2	2.9	1.1	.6
	4	6.3	3.5	1.2	.7
	5	7.1	4.3	1.3	.8
	Average infiltration velocity for five hour period, ins/hr.	1.42	.89	.26	.16

[1] Vista sandy loam profile: 0-30" brownish gray sandy loam; 30-36" decomposed granite showing some cemetation; 36"- crumbly dark decomposed granitic material, high in biotite. Parent rock--Gabbro. Substrata ring 1 at 30", 2 at 58".

[2] Fall brook sandy loam profile: 0-6" reddish brown sandy loam; 6-28" dull reddish brown loam; 28"- crumbly decomposed granitic material, lighter than vista soil. Parent rock--Tonalite. Substrata ring 1 at 28", 2 at 23".

[3] Escondido loam profile: 0-26" grayish brown loam; 26-28" yellowish brown decomposed schist; 28"- slightly weathered mica schist. Parent rock--Metamorphic gneiss and schist. Substrata ring 1 at 16", 2 at 26".

These data indicate that wide differences between permeability of the surface soil and the substrata may result in temporary periods of a perched water table i.e., a saturated condition of the soil directly above the restricting stratum. Moreover, the low permeability of the substratum may result in an excessive down-slope movement of water, creating a drainage problem with lower-lying land areas.

California

WETTING FRONT ADVANCE MAY INDICATE FURROW ABSORPTION RATE

V. S. Aronovici, Pomona.--Recently completed laboratory experiments with models suggest the possibility of estimating furrow absorption rates by measuring the rate of advance of the wetting front for a given soil or soil condition. The following table of data summarizes the results of such measurements for a sandy soil and one of clay texture.

Relation between distance of advance of wetting front, furrow absorption and time

Distance out from furrow	Imperial clay		Coarse sand	
	Elapsed time	Water absorbed per centimeter of furrow	Elapsed time	Water absorbed per centimeter of furrow
Centimeters	*Hours*	*Cubic cm.*	*Hours*	*Cubic cm.*
5	0.83	3.5	0.01	2.0
10	2.75	5.2	.04	4.3
15	5.50	7.7	.09	6.3
20	9.16	10.1	.16	8.4
30	20.00	15.0	.35	12.5
50	43.32	26.0	.92	22.0
100	150.00	46.0	3.67	42.0

Fine textured soils are found to have an extremely wide range in soil moisture from the furrow source to the wetting front. The coarse textured soils, on the other hand, show a rather uniform moisture content--although considerably lower at the source and higher at the wetting front.

These model studies also show that when the downward advance of the wetting front reaches a barrier, (a) lateral advance of the wetting front increases and (b) the furrow absorption rate slightly decreases.

Oregon

SOIL MOISTURE LOSSES AFTER IRRIGATION ARE MEASURED

Fred M. Tileston, Ontario.--Basic soil and soil moisture data are being collected from three border irrigation experimental sites in central Oregon. Some of these are summarized in the accompanying table.

Data being collected from these sites for the purpose of determining the degree of correlation of measured field intake rates with those determined with the ring infiltrometer are as yet incomplete.

Some interesting observations are made from samples from the Hall and Perkett ranches (a) taken 2 days after irrigation and (b) taken 6 & 5 days, respectively, after irrigation. There was a moisture loss of 0.65 inches depth in 4 days from the Hall ranch plot or an average loss of 0.16 inch per day. The field capacity of this 4-foot soil profile is probably in the range of 9.05" to 8.40" depth of water.

The Perkett ranch samples showed an average daily soil moisture loss of 0.17" depth for three days following irrigation. The field capacity for this soil is in the range of 6.56" to 6.04" for the 2-foot profile. This value for the soil on the Putman ranch is probably near 6.28" for the 2-foot crop root zone.

Soil moisture (percentages of dry weight of soil and inches depth) at various soil depths preceding and following irrigation on three Oregon ranches, April and May, 1955

Soil depth	Apparent density of soil (weight per cu. cm.)	Soil moisture on 3 dates: First		Second		Third	
		Percent of soil weight	Depth	Percent of soil weight	Depth	Percent of soil weight	Depth
D. E. Hall ranch near Alfalfa, Ore., irrigated 4/26/55							
Sampled:		4/25/55		4/28/55		5/2/55	
Feet	*Grams*	*Percent*	*Inches*	*Percent*	*Inches*	*Percent*	*Inches*
1.........	1.21	12.8	1.55	22.6	2.74	20.3	2.46
2.........	1.33	13.2	1.75	20.3	2.69	17.4	2.32
3.........	1.33	9.1	1.21	16.0	2.13		[1] 2.13
4.........	1.33	10.11	1.34	11.2	1.49		[1] 1.49
Total...			5.85		9.05		8.40
Paul Perkett ranch near Redmond, Ore., irrigated 4/27/55							
Sampled:		4/26/55		4/29/55		5/2/55	
1.........	1.23	18.2	2.24	28.8	3.53	23.4	2.88
2.........	1.30	25.1	3.27	23.4	3.03	[2] 24.2	[2] 3.16
Total...			5.51		6.56		6.04
Lee Putman ranch near Redmond, Ore., irrigated 4/29/55							
Sampled:		4/25/55		4/26/55		5/2/55	
1.........	1.16	22.3	2.59	13.7	1.59	26.8	3.11
2.........	1.35	20.5	2.77	12.2	1.65	23.5	3.17
Total...			[3] 5.36		3.24		6.28

[1] Assumed same as 4/28/55 sampling
[2] Average of 4/26/55 and 4/29/55 second-foot sampling
[3] Border was abandoned due to previous irrigation

DRAINAGE

Idaho

METHODS OF MEASURING HYDRAULIC CONDUCTIVITY TO BE COMPARED

R. W. Nelson and Claude H. Pair, Boise.--The objectives of a draininge study just started in the Idaho area are as follows:

(1) Determine the reproducibility of four field methods of determining hydraulic conductivity in different textured soils.

(2) Determine the variation of the cavity geometry and its effect on the A-function as described by Kirkham and Frevert in different textured soils.

(3) Obtain a field check on the adequacy of A-functions determined from model studies as utilized for field measurement of hydraulic conductivity.

(4) Obtain an approximate time requirement using each of the various methods of determining hydraulic conductivity.

One factor affecting the amount of water a given soil stratum will transmit is its hydraulic conductivity. Several methods have been devised for field measurement of this factor. The methods to be used in this study are the auger hole and piezometer methods as described by Dr. Kirkham, the two-hole method as developed by Dr. Childs, and a modified auger hole method.

The following data are to be collected during the study:

(1) Data for the calculation of hydraulic conductivity by each of the above methods.

(2) An estimate of the variability of hydraulic conductivity in each method of measurement.

(3) An estimate of the variability between hydraulic conductivity methods as affected by different soil textures.

(4) An estimate of the adequacy of A-functions determined from model studies.

California

INTERCEPTOR DRAIN RECOMMENDED FOR LANGRIDGE CAMP AREA

Leonard Schiff, Bakersfield. --The Outside Canal, which traverses the Langridge Camp Addition to the Los Banos SCD in Central California, has been suspected as a source of seepage water contributing to a high water table in the area.

Exploratory observations were obtained from piezometers and shallow wells installed downslope across the canal. Water levels revealed a shallow water table at less than one to four feet depth on a gradient somewhat paralleling the soil surface.

Hydraulic conductivity based on the auger hole method (Kirkham formula) was found to be two or more inches per hour.

The exploratory work led to a recommendation that an interceptor drain ditch be installed a short distance below the Outside Canal. Seepage from the canal and water flowing beneath it due to pressure from the overall hydraulic gradient would be caught by this interceptor ditch.

California

FLUCTUATING WATER TABLE DAMAGES ORCHARDS

Dean C. Muckel, Berkeley. --An investigation of drainage was completed in the East Contra Costa Soil Conservation District at the request of the Soil Conservation Service. It was found that the water table fluctuated from 5 feet to 10 feet below the land surface during the past 17 years. Many orchards have died and have been replaced with shallow rooted crops. Quality of the shallow water apparently was the primary cause of orchard deterioration. Trees died in areas where depth to ground water was adequate for normal growth, but severe damage resulted from boron content as high as 12 parts per million, chlorides running as high as 2,000 parts per million, and sulphates up to 800 parts per million in the capillary fringe.

Iowa

LISTING FOR CORN HELPS CONTROL EROSION IN WESTERN IOWA

W. E. Larson, Ames.--Listing corn on the contour can go a long way toward control of erosion on the loess soils of Western Iowa. This is what has been found in a recent experiment at the Western Iowa Experimental Farm near Castana and in earlier experiments at the Soil Conservation Experimental Farm near Shenandoah.

Soil and water losses as influenced by tillage practice were measured on an Ida silt loam soil with a 14 per cent slope and in two experiments on Marshall silt loam soils with 8 and 10 per cent slopes. Because of the difficulty of measuring large amounts of soil and water, two of the plots were small and most tillage operations were by hand. However, the tillage closely simulated what would be obtained with tractor-powered tools.

Mean soil and water losses for the experiment on Ida silt loam are presented in Table 1. The common practice of surface planting corn up-and-down hill resulted in a mean yearly loss of 26.1 tons of soil per acre and 3.5 inches of water. Surface planting corn on the contour resulted in 9.8 tons per acre soil loss and 2.2 inches of runoff, whereas only 2.6 tons per acre soil loss and 1.3 inches of runoff resulted from contour listing.

The effectiveness of contour listing as compared to listing up and down hill is also illustrated in two experiments on Marshall silt loam. The results are given in Table 2. In experiment IV conducted between 1933 and 1939 soil losses were reduced from 27.2 to 5.2 tons per acre per year by contour listing as compared to up-and-down-hill listing. Runoff was reduced from 2.54 to 0.49 inches per year. In the other experiment conducted during 1944, 1946, and 1947 annual soil losses from contour listing were 3.9 tons per acre per year as compared to 25.0 tons for up-and-down-hill listing. Runoff was 1.14 and 2.92 inches for contour and up-and-down-hill listing, respectively.

The slope lengths on the plots from which soil and water loss measurements were made are shorter than most slopes in the area. However, the slope lengths between terraces in the Ida and Marshall soil areas are commonly about the same as the slope length in the plots. Thus, it is felt that the soil and water loss values are applicable to terraced land on Ida and Marshall soils.

The row lengths on the contour plots were very short and exactly on the contour. On a field basis the listed furrows usually deviate from the contour slightly. Heavy water concentrations in the furrows will sometimes cause water to break over in low places. Although contour listing on a field basis may not be as effective as is indicated from the above data, experience has shown that it is a very satisfactory tillage method for erosion control.

Corn yields from listing have also been very satisfactory on the loess soils of Western Iowa as evidenced by many experiments. The corn yields from the runoff plots at the Western Iowa Experimental Farm are given in Table 3 and are generally representative of the other experiments. In this experiment corn that was surface planted up and down hill produced an average yield of 56.8 bushels per acre. Corn surface-planted on the contour yielded 62.7 bushels per acre, and corn listed on the contour produced 62.0 bushels per acre.

TABLE 1.--Soil and waterlosses as affected by tillage and cropping practice on IDA silt loam*

Cropping system	Soil loss per acre	Runoff
	Tons	*Inches*
Corn-oats (Sweet Clover)		
Surface planted up-and-down hill....................	26.1	3.47
Surface planted on the contour......................	9.8	2.20
Listed on the contour...............................	2.6	1.30
Corn-oats-meadow-meadow		
Contour listed......................................	1.4	0.70

*14 per cent slope; slope length 72.6 feet; plot width 10.5 feet. 1948-54

TABLE 2.--Soil and water losses from up-and-down hill and contour loose ground listing on Marshall silt loam

Tillage treatment	Experiment IV[1]		Experiment VIII[2]	
	Runoff per year	Soil loss per acre per year	Runoff per year	Soil loss per acre per year
	Inches	*Tons*	*Inches*	*Tons*
Loose ground listed up-and-down hill..	2.54	27.2	2.92	25.0
Loose ground listed on the contour....	0.49	5.2	1.14	3.9

[1] Marshall silt loam soil, 9 per cent slope. Slope length 157.5 feet, plot width 42 feet for up-and-down hill and 84 feet for contour. 1933-39 from Browning et. al., USDA Tech. Bul. 959. 1948

[2] Marshall silt loam soil, 10.5 per cent slope. Slope length 72.6, plot width 10.5 feet. 1944, 46, 47.

TABLE 3.--Corn yields as affected by tillage and cropping practice on Ida silt loam 1950-54

Cropping system	Yield per acre
	Bushels
Corn-oats (sweet clover)	
Surface planted up-and-down hill..................	56.8
Surface planted on the contour....................	62.7
Listed on the contour.............................	62.0
Corn-oats-meadow-meadow	
Listed on the contour.............................	63.6

BEST USE OF CHISEL TO CONTROL WIND EROSION ON ONE SOIL SPECIFIED

N. P. Woodruff and W. S. Chepil, Manhattan.--The chisel-type tillage implement is widely used on the Great Plains in the emergency tillage operation for wind erosion control. A study was undertaken to obtain information relative to the most effective use of the chisel for this operation.

Sixteen plots, each 30 by 100 feet, were laid out on a fallow field at Hays. The soil at Hays is Munjor silty clay loam and had an average 16.4 percent moisture content in the 0-9-inch depth at the time of tillage. The plots were tilled at different speeds, depths, suction angles of chisel points, and spacing of chisels. Draft was measured also for each test, and horsepower requirements were computed. The effectiveness, in terms of roughness, erodibility by wind, and clod structure, of the various soil surfaces created by each chisel operation was tested with the portable wind tunnel, the dust-catching equipment, and the rotary sieve. Draft tests and wind tunnel tests were run in triplicate. Clod structure and soil moisture content analyses were run in quadruplicate.

The results of this initial study are summarized in the following paragraphs. Since these results were obtained on only one representative soil type and one soil moisture condition, they are not applicable to all soils and moisture conditions.

Preliminary measurements on the influence that the tillage operation had on soil erodibility indicates that:

1. All tillage treatments produced a significant reduction in erodibility from the check. However, none of the tillage treatments produced a significant difference from any other tillage treatment.

2. Erodibility decreased with increased speed of tillage, probably because increased speed produced greater roughness. Five chisels set at an approximate 25-degree face angle were more effective in roughening the surface than 3 or 5 chisels with a 34-degree face angle.

The results obtained with regard to draft and horsepower requirements indicated the following:

1. Draft and horsepower requirements increased with depth for a given speed and chisel face angle.

2. Increasing the face angle of the chisel points apparently had little effect on draft and horsepower requirements.

3. Using 3 chisels instead of 5 would reduce power requirements approximately 5 horsepower.

Conclusions based on standards which considered both the effectiveness and the economics of operation, i.e., the time and cost of the operation, were as follows:

A. In general,

   1. Tillage at high speeds, while permitting a high rate of land coverage, did tend to pulverize the clods and did not produce a condition which would remain resistant to erosion for any great length of time.

   2. Tillage at very slow speeds indicated not only a slow rate of land coverage but also produced a "mole-like" effect which did not provide sufficient upheaval of the soil to give a uniform cloddy surface.

3. Chiseling too deep caused a high horsepower requirement and also did not provide sufficient upheaval to give a uniform cloddy surface.

B. Specific operations tested in this study.

1. Chiseling with 5 chisels set at an approximate 25-degree face angle, with 27-inch spacing between chisels in fourth gear (3.7 mph.) at a 3-inch depth appeared to most nearly meet the requirements for this soil type and soil moisture condition.

2. Tests with 3 chisels (54-inch spacing) tilled to 5.5-inch depth indicate that fourth gear (3.7 mph.) would be the best speed under the conditions tested.

3. Tests with 5 chisels with the greater face angle (approximately 34 degrees) tilled to 4-inch depth indicated that fourth gear (3.7 mph.) would be the best speed.

The rather interesting and sometimes drastic effects on the tillage caused by this face adjustment indicate a need for more detailed study of the suction and face angles.

Texas

EXTREME VARIATIONS IN EROSION OF PLOTS NOTED

R. M. Smith, Temple.--The total amount of rainfall for the first 6 months of 1955 was 0.28 inch above normal. February, May and June were above normal but January, March and April were below. The soil profile was dried out to six feet or more in the spring of 1955 following the drouth of 1954.

There was no runoff until May 6 when we had a strong wind and a very high rainfall intensity. A total of 1.90 inches of rain was recorded in 28 minutes. The maximum intensity was 3.8 inches per hour for 30 minutes, 5.92 inches per hour for 15 minutes and 8.16 inches per hour for 5 minutes. The 5-minute and the 15-minute intensities were the highest ever recorded at Temple during our 24 years of record.

The soil was dry and cracked on all runoff plots that were growing oats or grass with clover. As a result, the water, even from the extreme intensity, ran into cracks and there was no runoff. On corn plots where the soil contained more moisture, fewer cracks, and a cultivated surface layer that covered all cracks, there was considerable runoff. The soil layer limiting water intake obviously was at or near the bare soil surface.

Excessive erosion from plot 0-1 compared to other corn plots was obvious but is not easy to explain. This plot has shown some tendency to erode worse than other plots in the past. The soil disperses somewhat more readily than soil from most other runoff plots, according to laboratory measurements. In addition, this plot had the minimum of surface residue, since it was in cotton (a low producer of residue) in 1954. Even so, the erosion compared to other plots is greater than might be expected. This illustrates the high variability which has often been noted in past data on erosion.

A comparison with past losses may be of interest. The average annual losses from 1942 through 1950, for corn and cotton plots, respectively, were 2.2 and 1.8 inches of runoff with 3.5 and 3.9 tons of soil loss. Average rainfall for this period was 32.2 inches, or 1.8 inches below normal.

For long-time rainfall of 34.0 inches per year the past records, since 1939, indicate an average runoff of 2.5 inches and average soil loss of 3.8 tons per acre for row crops on the 0 and P plots, with average slope of 2.3 percent. This amounts to an average soil loss of 1.5 tons per inch of runoff. The 1955 data amount to an average soil loss of 2.4 tons per inch of runoff. If the highly-erodible plot, 0-1, is omitted from averages,

the other corn plots lost 1.19 inches of water and 1.96 tons of soil, or an average of 1.6 tons of soil per inch of water lost. This is very close to the long time average.

Trash mulch procedures have been used on all of the O and P runoff plots since 1952. Before 1950, conventional methods of land management were used.

Texas

ERODIBILITY OF SANDY SOILS DETERMINED BY DRY AGGREGATE SIZE

James R. Coover, SCS, and W. C. Moldenhauer, SWC, Big Spring. --This report is based on a project designed to determine the comparative erodibility of the most prevalent soil types of the Southern High Plains using samples from virgin sites. Data are interpreted in terms of pounds per acre of cover necessary to keep erosion within certain limits and in the amount of soil loss that can be expected if roughness and cover are at a minimum. Since clods larger than .84 mm are extremely unstable in the fine sands and loamy fine sands, it was considered justifiable to put the entire emphasis on cover.

Each soil type except Tivoli fine sand and Springer fine sand were sampled several times as noted in the accompanying table. Each of the two A horizon samplings were replicated 4 times at each site. The B horizon was sampled only once in each case.

The percentage of aggregates smaller than .84 mm was determined for each site sampled. For most of the soil types, differences were not great between sites. For Brownfield fine sand, site number 4 was more erobible in the first six inches than were the other two sites, but all three sites were about the same below six inches. Considerable difference occurred between sites in the Amarillo fine sandy loam, but the differences were not consistent throughout the profile. Site 12 had the most erodible surface but the least erodible A horizon below the surface. (This 0-1 inch layer was undoubtedly accumulated sand). It was very difficult to get virgin samples of this soil type since practically all of it has been plowed.

The table gives the soil erodibility index, 101, maximum soil loss per acre with minimum roughness and cover, and weight of residue necessary to keep erosion within certain limits.

The extreme erodibility of Tivoli fine sand can be seen. The surface inch is the least erodible portion of the first 30 inches.

In Springer fine sand, the surface inch is less erodible than the A horizon directly below it. On Brownfield fine sand, a large amount of cover is necessary to keep erosion at a minimum. Erosion will be severe when cover is at a minimum since fractions larger than .84 mm are very unstable.

Erosion losses from Brownfield loamy fine sand will be severe when cover is at a minimum. This is the reason for the popularity of deep plowing of this soil to get part of the B_2 horizon mixed with the A horizon.

In the Portales and Amarillo fine sandy loams the larger clods appear to be stable, and roughness can be taken into account. The amount of residue required to keep erosion within moderate limits on these soils is considerably less than is required by the four soil types previously discussed.

Amarillo clay loam was sampled and analyzed here for comparison with the sandy soils of the area.

Erodibility index, weight of residue required to keep erosion within certain limits, and maximum soil loss per acre with minimum roughness and cover for the seven most prevalent soil types on the Southern High plains of Texas

Soil type	Soil unit	Depth and thickness of horizon (inches)	% of aggregates smaller than .84 mm	Soil erodibility index (10I)	Weight of residue per acre to keep erosion within indicated limits			Maximum soil loss per acre with min. RK
					Insignificant (.001-.25 T/acre soil loss)	Moderate (.25-5.0 T/acre of soil loss)	High to v.high (5.0-maximum T/acre of soil loss)	
	Inches	Percent	Percent	Index	Pounds	Pounds	Pounds	Tons
Tivoli fine sand (one sample)	13-HP	0-1	80.6	30.8	1400-3000+	420-1400	100-420	200
		1-6	95.4	323.0	3000+	900-3000+	100-900	1600
		6-30	96.1	379.5	3000+	1200-3000+	100-1200	2200
Springer fine sand (one sample)		0-1	86.5	61.0	1750-3000+	550-1750	100-550	400
	12x	1-9	91.1	133.2	2500-3000+	750-2500	100-750	310
		9-18	75.0	16.0	1100-3000+	310-1100	100-310	80
Brownfield fine sand (average of 3 samples)		0-1	81.0	32.0	1400-3000+	400-1400	100-400	150
		1-6	84.1	45.6	1600-3000+	500-1600	100-500	240
	12HP	6-18	77.1	20.2	1200-3000+	340-1200	100-340	100
Brownfield loamy fine sand (average of 3 samples)		0-1	78.1	22.3	1200-3000+	350-1200	100-350	110
		1-14	80.6	30.8	1400-3000+	420-1400	100-420	200
	L12	14-21	12.2	.03	100 -900	----------	----------	0.15
Portales fine sandy loam (average of 2 samples)		0-1	68.3	8.3	780 -3000+	250-780	100-250	.50
		1-10	52.8	2.4	440 -3000+	140-440	100-140	.12
	7x-Hp	10-20	29.7	.35	220 -1800	100-220	----------	1.7
Amarillo fine sandy loam (average of 4 samples		0-1	59.5	4.0	600 -3000+	170-600	100-170	20
		1-10	43.7	1.2	370 -3000+	100-370	----------	6
	7 HP	10-21	20.8	.28	150-370	100-150	----------	0.7
Amarillo clay loam (average of 3 samples)		0-1	50.4	1.9	410 -3000	100-410	----------	11
		1-6	18.2	.08	100 -1200	----------	----------	0.35
		6-20	4.9	0	----------	----------	----------	0

Puerto Rico

MERKER GRASS RESPONDS MARKEDLY TO NITROGEN FERTILIZATION

J. Vincente-Chandler, S. Silva, J. Figarella, Rio Piedras.--The following tabulation shows the effect of nitrogen fertilization on the yield and protein content of Merker grass cut every 60 days. The experiment was conducted on level, moderately fertile soil, well fertilized with lime, phosphorus and potash.

Merker grass yields (dry matter and protein) and protein content at various levels of nitrogen fertilization

Nitrogen applied per acre yearly	Yields of Merker grass (dry matter) per acre yearly	Protein content	Protein yield per acre yearly
Pounds	*Pounds*	*Percent*	*Pounds*
0	14,000	6.5	910
100	16,800	6.8	1,140
200	17,500	6.8	1,190
400	31,000	7.5	2,320
800	36,400	8.4	3,050
1,200	36,400	9.6	3,500

These data clearly show the response of Merker grass to nitrogen fertilization. Yields increased markedly with nitrogen fertilization up to applications of 800 pounds of nitrogen per acre yearly. Yields of forage were more than doubled by applying this amount of nitrogen, compared with no nitrogen fertilization.

Light applications of nitrogen fertilizer did not appreciably affect the protein content of the forage. The protein content, however, increased with applications of nitrogen in excess of 400 pounds per acre yearly.

Protein yields rose as nitrogen fertilization was increased up to 1,200 pounds of nitrogen per acre yearly. Yields of protein were almost quadrupled by applications of 1,200 pounds of nitrogen per acre yearly.

The results of this experiment show that very heavy nitrogen fertilization may be profitable in large areas of the Tropics where rainfall is abundant. The data indicate that an acre of heavily fertilized Merker grass can produce enough nutrients to supply the needs of four dairy cows producing 10,000 quarts of milk yearly. About 6 young beef animals could be maintained on an acre of such grass.

North Dakota

ADDED N INCREASES ABSORPTION OF BANDED FERTILIZER P

D. L. Grunes and S. H. Shih, Mandan.--Companion growth room and field experiments were conducted to determine the effect of source and placement of nitrogen on the relative availability of soil and fertilizer phosphorus to plants.

Barley was grown in a controlled light-temperature plant growth chamber on seven soils whose pH varied from 6.4 to 7.9. As shown in the growth room data presented in the accompanying table, the addition of nitrogen fertilizer generally tended to increase the percent of phosphorus absorbed by plants from a band of concentrated superphosphate.

The addition of ammonium sulfate with the phosphorus band was generally more effective in increasing the percent of phosphorus absorbed from the fertilizer than was application in separate bands.

However, on the highly calcareous subsoil (Towner or Glyndon) loam, separating the ammonium sulfate and phosphorus bands was as effective in increasing the percent phosphorus absorbed from the fertilizer as was banding them together. Placement of sodium nitrate with the phosphorus band or on the opposite side of the plants from it was approximately equally effective in increasing the percent of phosphorus absorbed from the fertilizer.

In data not shown here, detailed studies on the Towner or Glyndon loam surface soil indicated that for banded applications of phosphorus, the percentage of phosphorus absorbed from the fertilizer was increased whether the nitrogen fertilizer was broadcast or banded. For broadcast applications of phosphorus, the addition of nitrogen was not generally effective in increasing the percentage of phosphorus absorbed from the fertilizer. While ammonium nitrate did tend to increase the percent phosphorus absorbed from the fertilizer, nitric acid, sulfuric acid, and sodium sulfate did not.

The following items seem to be related to the magnitude of increase in percent of phosphorus absorbed from phosphorus fertilizer bands following the addition of nitrogen:

(a) Amount of growth response to the added nitrogen.

(b) Decrease in pH following the addition of residually acid nitrogen fertilizers.

(c) Increase in root growth in the vicinity of the phosphorus band following the addition of nitrogen fertilizers.

In general the results obtained in the growth room and field experiments were similar. However, while in the growth room, ammonium sulfate was generally the most effective source for increasing the percent phosphorus absorbed from the fertilizer, ammonium nitrate and sodium nitrate were approximately equally as effective in the field.

Percentage of phosphorus absorbed from fertilizer by plants grown in various soils under five fertilizer treatments

Fertilizer treatment	Phosphorus absorbed in--							
	Towner or Glyndon Loam *0-7"	Towner or Glyndon Loam *7-21"	Cheyenne Fine Sandy Loam, unmanured *0-7"	Cheyenne Fine Sandy Loam, Manured *0-7"	Williams Loam *0-6"	Huff Loam *0-7"	Ulen Loamy Sand *0-7"	Mean all soils --
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
P band..............	38	36	71	15	38	28	34	37
Ammonium sulfate banded with P.....	70	59	90	24	58	67	59	61
Ammonium sulfate banded opposite P.	53	58	71	11	46	57	50	49
Sodium nitrate banded with P.....	55	64	75	19	57	53	42	52
Sodium nitrate banded opposite P.	60	60	81	16	58	50	34	51
Mean, all treatments	55	55	78	17	51	51	44	--

*Field sampling depth

ALFALFA GROWN WITHOUT MANURE DEPLETES AVAILABLE PHOSPHORUS

Fred E. Koehler, Lincoln.--Different crops and cropping systems vary considerably in the extent to which they deplete available soil phosphorus. Alfalfa, which has a large requirement for phosphorus, reduced the concentration of available soil phosphorus much more than did potatoes in an experiment at Scotts Bluff. Oats and barley were intermediate in this respect.

Available phosphorus was determined on soil samples taken from some old rotation plots at the Scotts Bluff Experiment Station. The Bray and Kurtz method was used (extracting solution was 0.03N NH_4F in 0.025N HCl). The rotations used and the results obtained are shown in the accompanying table. Most of the rotations were started in 1912 and terminated in 1949. Soil samples were taken in 1949 and the samples representing soil depths of 0-6" and 6-12" were used in this study.

In all cases where alfalfa was grown without the addition of manure, the available phosphorus was quite low. In rotation 63B, even the use of an average annual application of 2 tons of manure per acre did not cause a very large increase in available phosphorus.

Continuous cropping with alfalfa resulted in the lowest values found at both depths while continuous potatoes gave the highest values of the cropping systems without manure. The use of the three year rotation of potatoes, sugar beets, and oats or barley reduced the available phosphorus to a much lower level than that obtained when oats or barley were grown continuously or where a two year rotation of sugar beets and potatoes was used. This indicates that one of the results of using a rotation is to utilize more completely the available nutrients from the soil.

The concentration of available phosphorus in the soil was greatly increased by the use of barnyard manure except in the case of rotation 63B.

The data presented here show that the lack of fertility maintenance practices can result in a low level of available soil phosphorus, even on a soil which was originally quite high in that element. This is especially true where a good high-producing cropping system including legumes is used.

Influence of past cropping and manurial practices on available phosphorus in soil of old rotation plots, Scott Bluff, Nebr.

Rotation	Crops and history	Available P	
		0-6"	6-12"
		P.p.m.	*P.p.m.*
4	Potatoes 1912-49	15.3	10.6
4B	Potatoes 1912-41. (M)* potatoes 1942-49	34.9	24.7
7	Oats 1912-41, barley 1942-49	9.8	6.3
7B	Oats 1912-41, (M) barley 1942-49	43.2	30.7
8	Alfalfa 1912-49	6.4	4.3
8B	Alfalfa 1912-41, (M) alfalfa 1942-49	34.1	10.2
20	Sugar beets, potatoes 1912-49	10.4	8.6
21	Sugar beets, (M) potatoes 1912-41; (M) sugar beets, potatoes 1942-49	34.6	23.1
35	Sugar beets, oats, potatoes 1912-41; potatoes, sugar beets, barley 1942-49	6.9	6.4

See footnote at end of table.

Influence of past cropping and manurial practices on available phosphorus in soil of old rotation plots, Scott Bluff, Nebr.--Continued

Rotation	Crops and history	Available P	
		0-6"	6-12"
		P.p.m.	*P.p.m.*
35B	(M) Sugar Beets, oats, potatoes 1912-41; potatoes, (M) sugar beets, barley 1942-49	28.4	20.2
41	Alfalfa 2 yrs., potatoes, sugar beets 1912-41; barley-alfalfa, alfalfa, potatoes, sugar beets 1942-49	7.7	5.5
63	Alfalfa 3 yrs., potatoes, oats, sugar beets 1912-41; barley-alfalfa, alfalfa 3 yrs., potatoes, sugar beets 1942-49	6.6	4.7
63B	Alfalfa 3 yrs., potatoes, oats, (M) sugar beets 1912-41; barley-alfalfa, alfalfa 3 yrs., potatoes, (M) sugar beets 1942-49	8.7	6.4

*(M) indicates manure applied at 12 tons per acre for the following crop mentioned.

Colorado

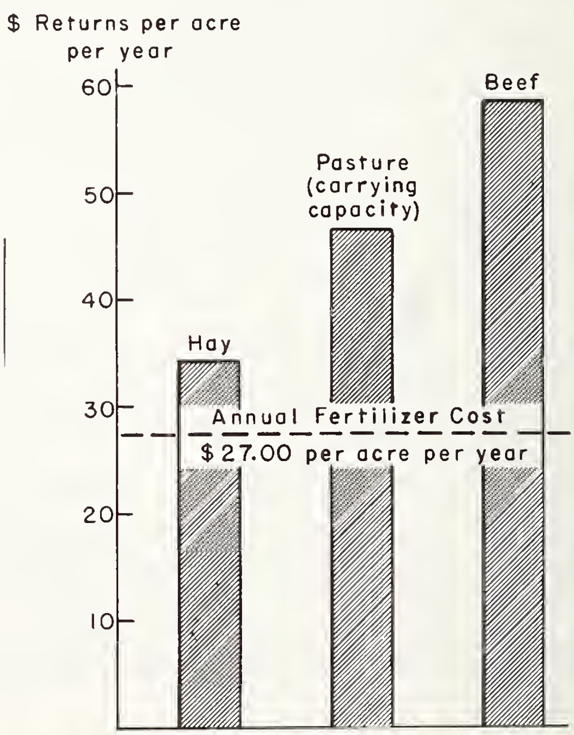
BEEF FROM MOUNTAIN MEADOWS REFLECTS PROFIT FROM NITROGEN

Forrest M. Willhite and Hayden K. Rouse, Grand Junction and Gunnison. -- Applications of basic and fundamental research findings from the Blackstock Factorial Experimental Site are now being studied. In 1953, 40 acres of mountain meadows were fertilized as a preliminary toward studying, feed utilization in relation to mountain meadow soil, water, and harvest management practices. Four fertility levels are considered, i. e., no treatment, 270 pounds of P_2O_5, 180 pounds nitrogen, and a combination of nitrogen and phosphorus fertilizer. Sufficient area was allowed to produce both hay and pasture on a year-round basis for livestock feed.

Six head of pure-bred Hereford heifers were confined on May 12, 1953, to grass produced on each fertility treatment. Sufficient hay and pasture were produced to carry them through two complete years. During this period the average weight of the cattle increased from 477 to 1,343 pounds.

Briefly, the economic result of this, placing $20 a ton as the value of hay, is a $7 net return for 180 pounds of nitrogen applied annually at 15¢ per pound. In respect to carrying capacity, allowing 20¢

Returns from ~~Mountain~~ Meadows in Relation to Cost of Nitrogen Fertilizer



per day per head, the return for the same amount of nitrogen applied for hay is $19.40 over the returns where no nitrogen was applied. In regard to beef production, allowing 20¢ per pound for beef gain, the trend is $31.20 per acre per year in favor of the nitrogen treatment as compared with no nitrogen treatment.

In this instance, phosphorus has not as yet influenced production significantly but there are indications that it may do so.

The agronomic and livestock data are given in the accompanying tables.

TABLE 1.--Production from mountain meadows in terms of animal days per acre, beef per acre, or acres required to carry one animal--associated with three fertilizer practices and no fertilizer, Hayden, Colo., 1953-1954

Treatment	Beef per acre		Animal days per acre		Acres required to carry 1 animal	
	1953	1954	*1953	**1954	1953	1954
	Pounds	*Pounds*	*Days*	*Days*	*Acres*	*Acres*
No fertilizer..........	349	270	240	228	1.52	1.60
Phosphorus............	333	334	225	262	1.62	1.39
Nitrogen..............	658	541	476	457	0.77	0.80
Nitrogen & phosphorus..	685	598	520	475	0.70	0.77

*Animal weight, starting May 12, 1953--477 lbs., ending May 14, 1954--979 lbs.
**Animal weight, starting May 14, 1954--979 lbs., ending Feb. 15, 1955--1,343 lbs.

TABLE 2.--Yields of hay and crude protein and the crude protein and phosphorus content of hay resulting from various fertilization practices on mountain meadows, Hayden, Colo., 1953-1954

Treatment	Yield per acre***				Crude protein content of hay		Phosphorus content of hay	
	Hay		Crude protein					
	1953	1954	1953	1954	1953	1954	1953	1954
	Tons	*Tons*	*Pounds*	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*
No fertilizer.....	2.40	2.29	479	540	10.0	11.8	.27	.25
Phosphorus*.......	2.21	2.87	468	682	10.6	11.9	.33	.30
Nitrogen**........	3.95	4.13	965	1,139	12.2	13.8	.23	.25
Nitrogen** & Phosphorus*.....	3.98	4.78	956	1,330	12.0	13.9	.28	.31

*Phosphorus applied in 1953 only at rate of 270 lbs. P_2O_5 per acre
**Nitrogen applied in 1953 at 200 lbs. per acre, in 1954 at 160 lbs. per acre as NH_4NO_3
***In 1953 all treatments were harvested 2 times; in 1954 the meadows with no fertilizer and those fertilized with phosphorus were harvested 2 times, the others 3 times.

New Mexico

FERTILIZER N INCREASES YIELD, PROTEIN CONTENT OF GRAIN SORGHUM

Ross W. Leamer, State College.--Grain sorghum grown on Tobosa Flats in the Tucumcari Irrigation Project yields more and has a higher protein content when nitrogen fertilizer is used. Phosphate fertilizer does not increase yield on newly irrigated soil but does affect the amount of phosphorus in the grain.

The Tucumcari project receives an average of 16 inches of precipitation per year. The soils developed in this rainfall belt are low in organic matter and consequently require additions of nitrogen for maximum production of irrigated crops. These soils vary

in their need for phosphate fertilization. The coarser textured Springer and Dalhart sandy loams require phosphate fertilization for maximum production while the fine textured Montoya clay loam does not respond to applications of phosphorus.

The data presented here are from a sorghum fertilizer experiment conducted on the experimental area in Tobosa Flats. Ammonium nitrate, treble superphosphate, and muriate of potash were applied at planting time in 1953 to give the indicated rates and combinations of N, P_2O_5, and K_2O. The residual effect of the 1953 fertilization was measured by planting the area to sorghum again in 1954. No fertilizer was applied to the 1954 crop. Samples of the grain from each plot were analyzed for protein (N x 6.25) and for phosphorus content. The data are summarized in the table that follows.

Statistical analyses of these data including a breakdown of the individual degrees of freedom show that nitrogen increased the yield and protein content of the 1953 grain at all levels of phosphorus. The main increase in yield came from the first 40-pound increment of nitrogen with a smaller increase from the second. There was no significant yield increase above 80 pounds of N per acre. The protein content also made the greatest increase from the first 40-pound increment of N and a highly significant increase from both the second and third increments. There was no significant difference in protein content of the grain from plots receiving 120 and 160 pounds of N per acre.

The phosphorus had no effect on either the yield or the protein content. However, it did increase the P content of the grain. The trends are not as well defined as with yield and protein content but the analysis of variance shows that phosphorus fertilization has a greater effect at the higher levels of nitrogen and that 40 pounds per acre is as effective as 80. There is also a tendency for nitrogen fertilizer to decrease the phosphorus content of the grain. This tendency was particularly apparent when no phosphorus was applied.

The yield data from 1954 show that nitrogen applied in 1953 had no effect on yield in the second year even though the rates applied in 1953 went well beyond the level required for yield increases.

Yield, protein content, and phosphorus content of grain sorghum averages of four replicates grown on fertilizer plots on Tobosa Flats, New Mex.

Fertilizer applied per acre			1953 yield per acre	1953 protein (N x 6.25)	1953 Phosphorus	1954 yield per acre
N	P_2O_5	K_2O				
Pounds	*Pounds*	*Pounds*	*Bushels*	*Percent*	*Percent*	*Bushels*
0	0	0	36.8	8.12	0.254	28.6
40	0	0	44.4	8.25	.197	23.5
80	0	0	45.4	9.06	.213	30.8
120	0	0	50.2	10.25	.221	34.0
160	0	0	55.7	10.75	.184	36.0
0	40	0	41.3	7.44	.268	34.0
0	80	0	40.2	7.56	.278	28.0
80	40	0	52.0	9.25	.249	29.4
160	40	0	58.5	11.12	.228	31.2
80	80	0	54.0	8.44	.256	36.3
160	80	0	54.4	10.25	.262	33.5
160	80	80	57.4	9.75	.231	34.6

GROWTH OF COTTON SIMILAR IN FIRST AND SECOND YEARS OF STUDY

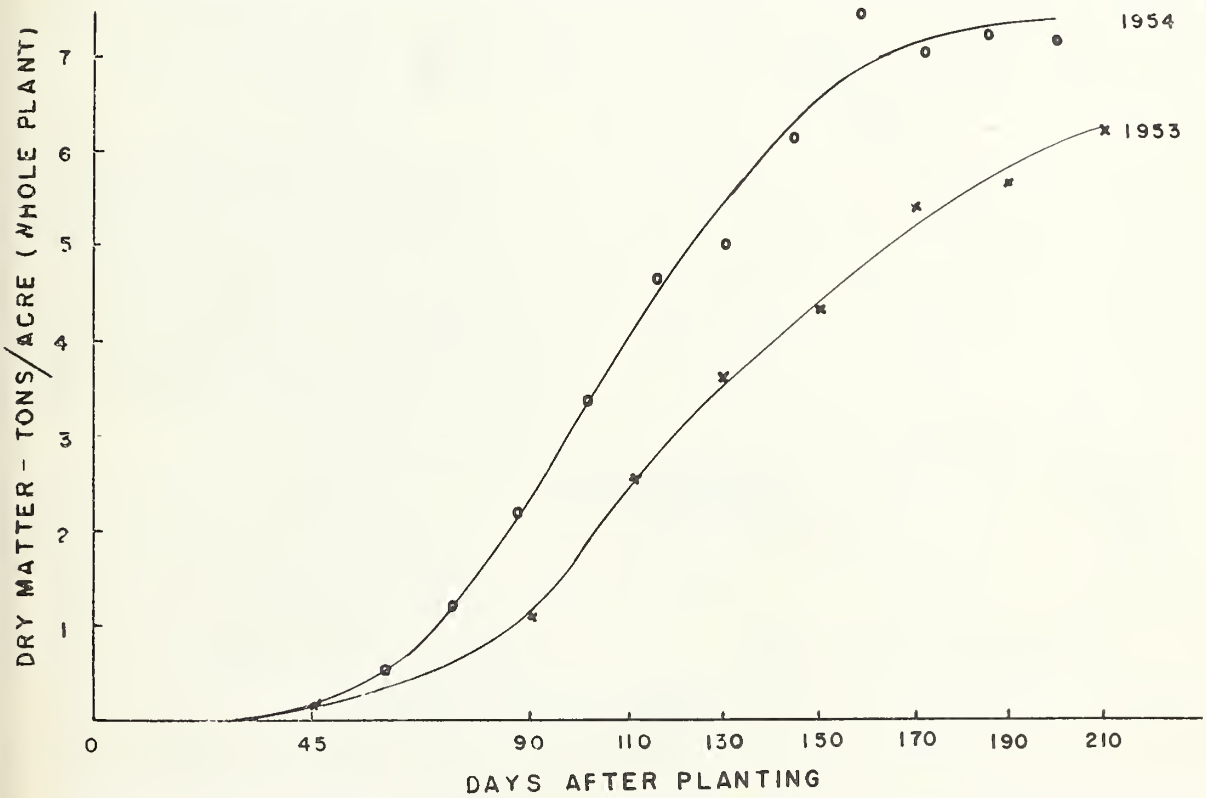
A. J. MacKenzie and K. R. Stockinger, Brawley.--In a second year study of the growth and nutrient uptake of well-fertilized and well-irrigated cotton, results similar to those of the first year were obtained although the climatic conditions for the two years were slightly different. The year of the first study, 1953, was characterized by below normal spring temperatures; the next year's study experienced a warm spring and good early growth. A longer period of high summer temperatures and humidity occurred during 1953 as compared to 1954. In general, climatic conditions were more favorable for the growth of cotton during the 1954 season. This resulted in a larger amount of dry matter being produced that year as well as a better yield; however, the growth curves for the two years (see graph) are quite similar. Summary of the two year study is as follows:

1. During the first 45 days of growth, for both years, approximately 2% of the total dry matter was produced.

2. The rate of growth after 45 days increases and the period of the maximum rate of dry matter production occurs 90-120 days after planting. In 1954, because of the more nearly ideal spring growing conditions, the increase in rate of growth started about 2-3 weeks earlier than in 1953.

3. Total dry matter produced in 1954 was 7.3 tons per acre which was 1.0 tons per acre better than in 1953. Yield of lint for 1954 was 3.52 bales per acre as compared to 3.24 bales per acre for the previous year.

4. Nitrogen uptake by the cotton for 1953 was 211 pounds N per acre, and for 1954 was 265 pounds. This nitrogen uptake corresponds to 65 and 75 pounds of N for each bale of cotton produced during those two years, respectively.



Accumulative dry matter production of well-fertilized, well-irrigated cotton grown on a Holtville silty clay soil, Brawley, Calif. 1953 and 1954.

Coloradc

SALINE-ALKALI SOIL POROSITY IMPROVED BY LEACHING PLUS CONDITIONER

W. D. Kemper and M. Amemiya, Grand Junction.--In a previously reported experiment for the reclamation of a saline-alkali soil (Billings silty clay loam) in the Upper Colorado River Basin, the major emphasis had been on the chemical changes taking place in the soil due to the several reclamation treatments. These chemical changes were evaluated in terms of crop response, using alfalfa as the indicator plant. Although alfalfa yields were well correlated with differences in soluble salt content and exchangeable sodium percentage in the soil, it was evident that differences in soil physical properties were also affecting, directly or indirectly, plant growth following reclamation.

Reclamation treatments, replicated four times, were as follows:

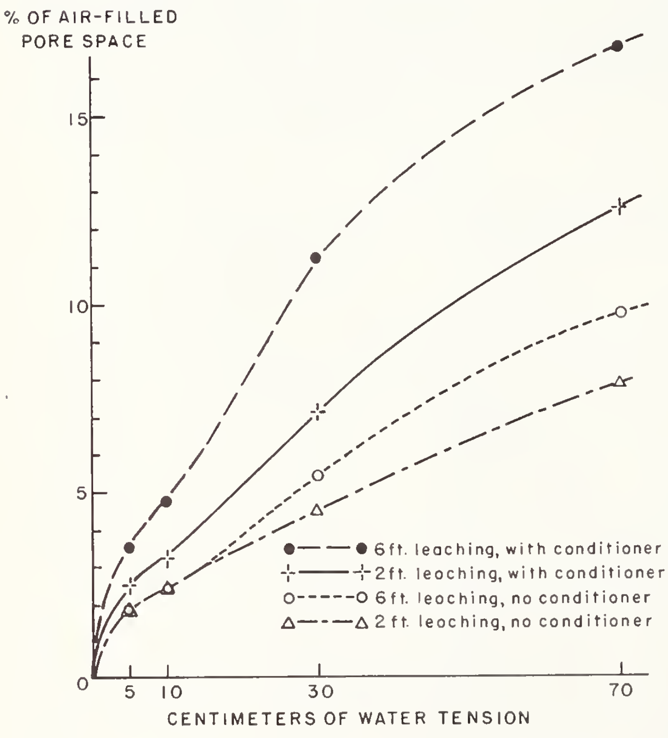
a. Leaching with 2 acre-feet of water per acre

b. Leaching with 2 acre-feet of water plus gypsum per acre

c. Leaching with 6 acre-feet of water per acre

d. Leaching with 6 acre-feet of water plus gypsum per acre

The effect of leaching and soil conditioner (VAMA) on pore size distribution in surface of Billings silty clay loam.



Grand Junction, Colo. 1955

Leaching was started in the summer of 1953 and completed in 1953, at which time alfalfa was planted in each of the plots. At the time of seedbed preparation, a 10-foot strip across the short axis of each of the 30' x 60' plots was treated with a VAMA soil conditioner (Krilium-186) which was incorporated into the surface 3 inches at a concentration of 0.1%.

This report covers a study of the pore size distribution in the surface soil of these plots. Undisturbed soil cores (2-3/8" diameter, 1 1/2" long) were taken from the VAMA-treated and non-treated portions of each plot. Cores were saturated and subjected to tensions of 5, 10, 30, and 70 centimeters of water to determine the relative size distribution pattern of the macro pores.

A summary of the determinations made to date is given in the accompanying graph. Since there were no differences due to gypsum, the values of the gypsum treated plots have been combined with those for their respective leaching treatments. The data indicate the following:

1. Differences between leaching treatments are significant at the 30 and 70 centimeter tensions;

2. Differences between the VAMA and no VAMA treatments are significant at every tension;

3. There is a significantly greater increase in pore space due to VAMA (through the 0 to 70 cm. range) in the case of the 6-foot leaching than in the 2-foot leaching plots.

This study is being continued in conjunction with investigations of other soil physical properties of the surface as well as sub-surface horizons of the profile.

Nebraska

SOIL CONDITIONER (HPAN) AFFECTS NITRIFICATION ONLY SLIGHTLY

F. L. Duley, T. M. McCalla, and R. E. Luebs, Lincoln. --When the soil conditioner (HPAN) was added to soils varying in texture from sands to clays and incubated for 12 weeks, there was only a slight effect in increasing nitrification of native nitrogen or nitrogen contained in straw or alfalfa. The data in the table that follows show that three of the five soils showed some increase with alfalfa residues. When the soil conditioner (HPAN) was added to field plots there was no measurable effect on nitrification. Over a 3-year period in the field, the nitrate content of soil without or with soil conditioner (HPAN) was similar. Apparently, in these soils physical condition either in the laboratory or field was not a limiting factor for nitrification.

Influence of soil conditioner (HPAN) on nitrification (as indicated by parts per million of nitrate nitrogen) in different textured soil after incubation for 12 weeks

Location and kind of soil	Kind of residue (0.4%)					
	None		Straw		Alfalfa	
	0.0% HPAN	0.2% HPAN	0.0% HPAN	0.2% HPAN	0.0% HPAN	0.2% HPAN
			PPM NO_3N			
Lincoln, Nebr. Sharpsburg silty clay loam....	35.5	32.6	7.5	11.8	68.1	108.4
Pawnee clay.................	23.1	13.7	0.0	0.0	40.8	53.2
Clay alkali (gumbo)...........	31.8	25.6	0.0	0.0	103.5	113.9
North Platte, Nebr. very fine sand................	60.5	50.6	28.1	13.6	84.3	80.2
Cherokee, Okla. fine sandy loam..............	31.6	26.6	1.2	1.2	67.1	67.9

CROPPING SYSTEMS

South Carolina

MID- AND LATE-SEPTEMBER PLANTINGS YIELD MOST FORAGE

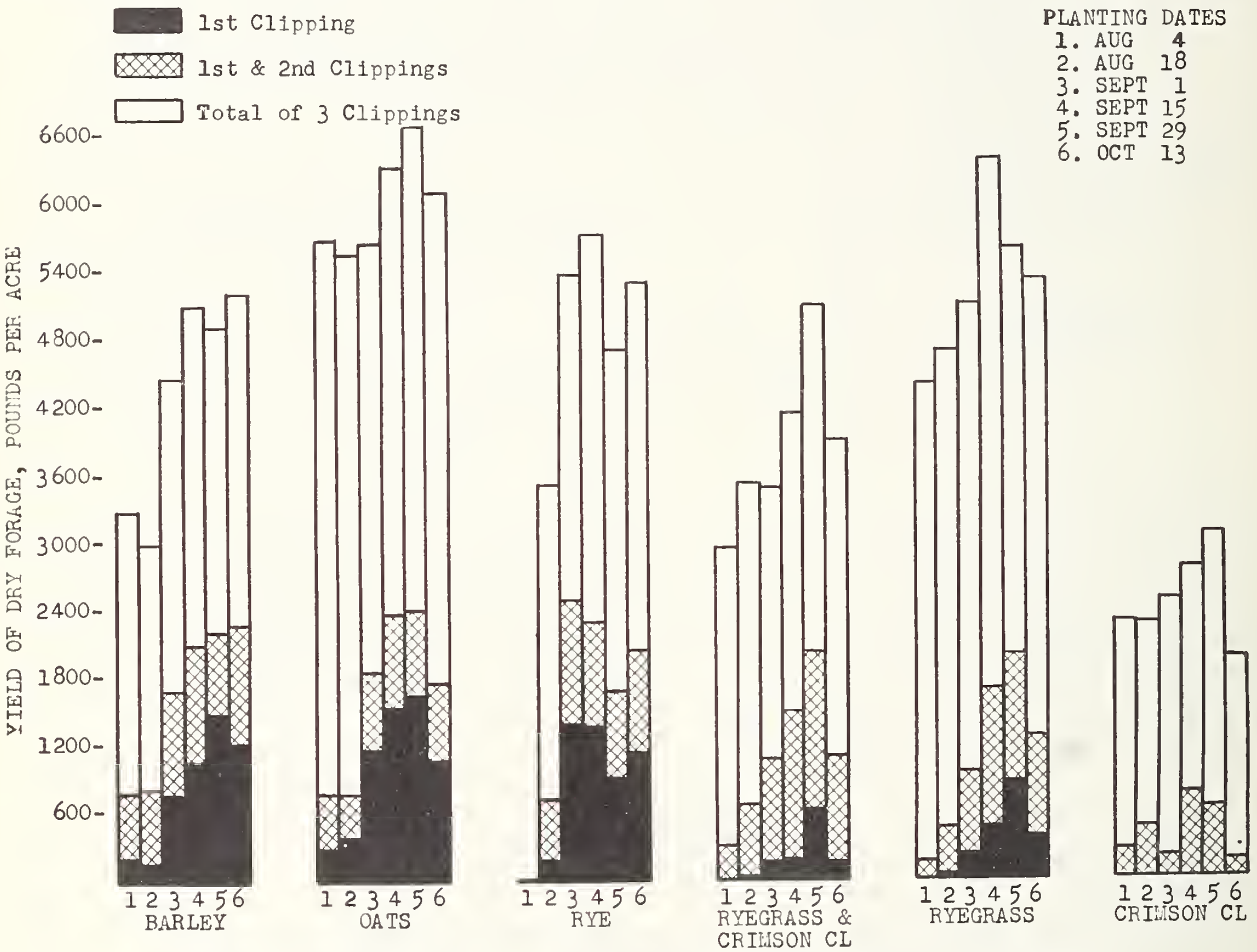
E. H. Stewart and E. B. Eskew, Clemson. --Mid-September and late-September plantings of annual forage crops resulted in the most early grazing and greatest total forage production in a test of six planting dates starting in August of 1954. August plantings produced the least forage at each clipping but were satisfactory for three crops. Oats seemed to be the superior crop in both early and total forage production.

Plantings were made at two-week intervals from August 4 to October 13, 1954. Crops planted were barley, oats, rye, ryegrass-crimson clover mixture, ryegrass, and crimson clover. The test was conducted on a Cecil soil which varies from a sandy loam to sandy clay loam and is representative of the soils in the Piedmont region.

In the four-month period from August through November, the total rainfall was 4.27 inches. Irrigation was employed to get the crops started on schedule. Two of the four replicates received additional irrigations when it appeared that moisture deficiency might reduce stands. These consisted of from one to three irrigations of about one inch of water, the later-planted crops receiving the fewer irrigations. The two remaining replicates served as checks to determine the effect of additional irrigation on yields.

Yield clippings were made on February 11, March 10, and at the hay cutting stage of growth for each crop. Yields are presented in the accompanying chart.

The earliest potential grazing was produced by the barley, oats, and rye, which were similar in growth pattern.



YIELDS OF WINTER ANNUAL GRAZING CROPS AS AFFECTED BY DATE OF PLANTING

The relatively poor showing of August plantings was believed due to hot dry weather, competition from crab grass and other summer annuals, and insect injury. However, the total yields of oats, ryegrass, and crimson clover planted in August were only a little lower than yields from later plantings and were satisfactory.

Plantings made after August were conspicuous by the absence of summer grasses, but from a practical standpoint the summer grasses may not be objectionable since they may be grazed to prevent too much competition with winter annual seedlings.

The first planting of rye was almost completely killed by the hot, dry weather, and the second planting was retarded somewhat.

The several irrigations following the initial irrigation did not increase the total forage production but did bring on production somewhat earlier. The additional irrigations greatly increased the competition from crab grass and other summer annuals, especially in the August plantings. The crops were quite drought-resistant when they received sufficient moisture at planting time to become well established.

Further testing is planned this fall. Soil moisture will be maintained at a higher level to determine what may be expected from these crops in the way of forage for livestock and early sod development for soil and water conservation.

Illinois

CLIPPING INTERCROP IMPROVES YIELD OF SKIP-ROW CORN

C. A. Van Doren, Urbana.--Two years of data are available on growing corn in a skip-row system. The primary purpose of this study, located on the Joliet Station, is to develop methods of growing corn in the same field year after year. Two rows are planted at the usual spacing and the adjacent row is skipped. A close-growing crop, usually a legume, occupies the wide space--skip-row area--for erosion control. Although no definite results are available, it is hoped that corn can be grown in the same space two or three years before rotating it into the legume area. When corn is rotated, the intercrop area will be seeded to a close-growing crop.

Corn yields for 1953 and 1954 are tabulated below:

Corn yields under skip-row and conventional tillage

Tillage method	Corn yields per acre	
	1953	1954
	Bushels	*Bushels*
Conventional........................	80.7	106.6
Skip-row (40"-80")..................	53.8	91.8
Percent reduction for skip-row........	-33%	-14%

Corn was planted in 1953 in a 3-year-old stand of alfalfa. Corn occupied the same location again in 1954. The difficulty of preparing a seedbed in 1953 suggested the desirability of killing established legumes in the space to be occupied by corn well in advance of planting. Preparation of a good seedbed was possible in 1954 since competition with alfalfa plants was eliminated.

Although yield reductions seem large, the system has possibilities for eliminating low-profit crops such as oats and retaining the valuable features of legumes grown in association with corn.

Five methods of managing the intercrop were tested in 1953 and 1954, as indicated in the accompanying table. Results are indicated in the accompanying table. In general, frequent clipping of the alfalfa resulted in higher corn yield than infrequent clipping and not clipping.

A companion study at the Joliet Station seeks to learn what species are best for use in the inter-crop spacings. Red clover, ladino clover, mammoth clover, alfalfa, winter vetch, and rye are under test. With the exception of vetch and rye, seedings are made in April. Approximately 60 inches of the 80-inch space between rows is seeded. Seedings were established in first- and second-year corn in 1955. No definite results are available on this part of the study.

Corn yields associated with alfalfa intercrop managed five ways, Joliet, Illinois, 1953-1954

Mulch management*	Corn yield per acre	
	1953	1954
	Bushels	*Bushels*
Not clipped........................	49	89
Clipped 3 times........................	62	94
Clipped 3 times, used as mulch........	60	97
Clipped 6 times........................	64	99
Clipped 6 times, used as mulch........	71	99

*Clipping refers to number of times intercrop was cut during season. Six clippings kept height of growth to 6 inches or less. "Used as mulch" refers to using intercrop clippings as mulch in corn row.

RESIDUE MANAGEMENT

Virginia

DOUBLE CUT PLOW METHOD OF MULCH TILLAGE SHOWS PROMISE

J. Nick Jones, Jr., and John E. Moody, Blacksburg.--The double cut plow method involves the complete inversion of the top 3-inch sod layer plus simultaneous subtillage of the 3 to 7-inch soil zone. (Agricultural Engineering Journal, Vol. 31:395-397, August 1950.)

This type of basic tillage is particularly effective in the management of perennial grass and legume residue mulches because the inversion of the sod layer and exposure of the root masses to climatic action results in a satisfactory kill of such vegetation. Furthermore, it is an effective way to reduce erosion by providing a protective mulch on the soil. A common farm tool such as the spring tooth harrow can be used to return the dead mulch material to the surface four to six weeks after the basic tillage is performed.

Using corn as the test crop, the double cut plow method of mulch management gave the following average yield and stand values for the 7-year period from 1948 to 1954.

The April-September rainfall during the test period varied from 7.6 inches below to 6.5 inches above the long time average. Distribution throughout the growing seasons was equally as variable, ranging from very poor to good.

The small average depressions in corn yield and stand from the mulch treatment are not statistically significant at the 0.05 level, but they do indicate the same trend found by so many investigators. The double cut plow principle, however, is the only mulch management scheme found thus far which does not cause prohibitive yield depressions following perennial grass and legume sods under Virginia conditions.

Treatment	Stand (stalks per acre)	Yield per acre	
		Stalks	Grain
	Number	*Pounds*	*Bushels*
Conventional--turn plow & discing........	11,514	0.343	71.3
Mulch--double cut plow and spring tooth harrow..................................	11,253	.336	68.0
Difference..........................	261	.007	3.3

Associated laboratory analyses show a slightly lower average N, P, and K content in the mature corn plant and in the corn grain under mulch. These average values for the 4-year 1951 to 1954 period are shown in the following table.

Nutrient content of mature corn plants[1] and grain produced with conventional and mulch tillage, four-year averages, 1951-54, Virginia

Treatment	Nitrogen in plant	Phosphorus in plant	Potash in plant	Nitrogen in grain, per acre
	Percent	*Percent*	*Percent*	*Pounds*
Conventional--turn plow and disc...	3.616	0.492	2.493	54.5
Mulch--double cut plow & spring-tooth harrow.....................	3.334	.467	2.298	52.3
Difference...................	0.282	.025	0.195	2.2

[1] Includes all growth above ground

Related studies showed the average amount of moisture in the 0 to 6-inch soil layer was 2.3 percent higher for the season under mulch than in conventionally tilled plots. Seasonal surface soil temperature averaged 3.9 degrees F. lower on the double cut plow-tilled plots during the day (6:00 A. M. to 6:00 P. M.) and 1.6 degrees F. higher at night. At 4-inch depths the differences under the mulch were 0.90 degrees F. lower during daylight and 0.1 degree F. higher at night. Limited microbiological studies indicated the conditions in the sod layer of the mulched plots seemed to stimulate certain soil fungi which might in turn affect the tieup of nitrate nitrogen.

South Carolina

CROP YIELDS NOT MUCH AFFECTED BY MULCH TILLAGE

O. W. Beale, G. B. Nutt, and T. C. Peele, Clemson.--Mulch and conventional turn-plow methods of tillage were used in a four-year rotation of cotton, wheat-Kobe lespedeza. Cotton was also grown each year without an intervening cover crop by the turn-plow method. There were 4 replicates of each treatment each year. The effects of the tillage methods on yields and soil properties were studied.

After cotton and corn were harvested, wheat was drilled. Kobe lespedeza was broadcast in the wheat in early spring. Wheat residues and the entire growth of lespedeza were used as mulch material or turned under for row crops of corn and cotton.

Mulch-tilled land was prepared for planting by disk-harrowing and ripping the soil with a spring-tooth field tiller to a depth of about 6 inches. The turn-plowed land was prepared by turn-plowing and disk-harrowing. All crops were planted with standard equipment.

Fertilizer applications for any crop were uniform for all treatments for any year, but varied some from year to year. Average annual applications were: for wheat--62 pounds of N, 41 pounds of P_2O_5 and 28 pounds of K_2O; for cotton--21 pounds of N, 59 pounds of P_2O_5 and 42 pounds of K_2O; and for corn--90 pounds of N, 59 pounds of P_2O_5, and 47 pounds of K_2O per acre.

Yields of mulched and clean-tilled seed cotton in the rotation were not different, except in 1948. Then the clean-tillage treatment resulted in a significantly greater yield than the mulch tillage. In general, the yield trends of the mulch-tilled cotton indicated some annual increases while yields under the clean-tilled method remained approximately the same. The yields of cotton in the rotation were greater than those of the clean-tilled continuous cotton most years. Mulch-tilled cotton plants were larger, and defoliation and boll opening were later than the plowed, clean-tilled cotton with and without cover crops. The yields of seed cotton under all treatments are shown in Table 1. The low yields in 1947, 1953, and 1954 were due to moisture deficiency.

Corn yields for the rotation are given in Table 2. No significant differences in yields have been obtained, except in 1951 when the plowed, clean-tilled corn yields were greater than the mulch-tilled corn yields. The average yields for the 8 years were equal.

Wheat yields, shown in Table 3, have varied little. Yields of wheat following cotton were usually somewhat greater than those following corn and were significantly greater than those following corn in 1953. Average yields were almost equal.

Aggregation of the soil after one cycle (Table 4) was greater in the mulch-tilled than in the plowed land. The aggregation of the turn-plowed soil under rotation was greater than that of the plowed check. Total soil nitrogen associated with the mulch treatment indicated an increasing trend but was not significantly greater than that of the plowed soil.

Crop yields apparently were not substantially affected by tillage methods, although the mulch method caused some improvement in fertility and tilth of the soil. The improvement in fertility and soil tilth was probably responsible for the larger mulch-tilled cotton plants. No such differences in the size of corn or wheat plants have been observed.

TABLE 1.--Effects of tillage methods on yields of cotton in rotation of cotton, wheat-lespedeza, corn, wheat-lespedeza, compared to continuous cotton with clean tillage

Tillage method	Preceding crop	Yields of seed cotton, pounds per acre								
		1947	1948	1949	1950	1951	1952	1953	1954	Av.
Mulch.....	Wheat-lesp.	366	1,235	1,641	1,512	1,347	1,822	901	661	1,186
Plowed....	Wheat-lesp.	448	1,549	1,741	1,718	1,390	1,754	971	717	1,286
Plowed....	Cotton.....	227	1,286	1,026	977	890	1,195	688	331	828
L. S. D. (0.05)		307	265	355	415	450	249	206	137	

TABLE 2.--Effects of tillage methods on yields of corn

Tillage method	Preceding crop	Yields of corn, bushels per acre								
		1947	1948	1949	1950	1951	1952	1953	1954	Av.
Mulch.....	Wheat-lesp.	17	58	38	102	40	42	42	--	48
Plowed....	Wheat-lesp.	21	57	40	93	51	35	46	--	49
L. S. D. (0.05)		9	8	9	12	7	10	12		

TABLE 3.--Effects of tillage methods on wheat yields in cotton, wheat-lespedeza, corn, wheat-lespedeza rotation

Tillage method	Preceding crop	Yields of wheat, bushels per acre								
		1947*	1948*	1949	1950	1951	1952	1953	1954	Av.
Mulch.....	Cotton....	39	--	23	21	26	23	24	25	24
Plowed....	Cotton....	39	--	24	21	25	27	24	26	25
Mulch.....	Corn......	37	--	25	19	24	24	15	17	21
Plowed....	Corn......	43	--	26	19	24	24	17	24	22
L. S. D. (0.05)		9	--	7	5	6	3	7	6	

*Oats were grown in 1947. Crop failed in 1948

TABLE 4.--Effects of tillage and crop rotation on soil properties

Tillage methods	Aggregation	Total nitrogen
	Percent	*Percent*
Mulch........................	46	0.064
Plowed.......................	38	.053
Check, plowed*................	31	.053
L. S. D. (0.05)	6	.018

*Check plots were cotton each year, no cover crop.

Texas

TRASH MULCH, CONVENTIONAL METHODS GIVE SAME GRAIN YIELDS

R. M. Smith, Temple.--Oat yields were almost a complete failure on plots as well as fields at Temple this year. The severe freeze of March 25 to 27 did some damage. Very dry conditions at critical times in March and April prevented oats from filling properly. Barley and wheat yields were low but were better than oat yields.

The results do not suggest any real differences in small grain yields between trash mulch and conventional methods in 1955.

Available soil nitrogen was very high in fields C-15 and C-16 from barnyard manure added to previous corn crops. Winter vegetative growth was excellent and about 70 pounds of steer gain per acre was obtained from winter grazing of these fields. The high nitrogen level was not beneficial to grain yield.

The trash-mulch-planted wheat on L-2 looked considerably better than wheat grown with conventional methods on L-3 because it was planted deeper in moist soil and came up sooner and more uniformly. The grain yield was slightly in favor of the trash-mulch planting.

Oat, barley and wheat yields in non-replicated field comparisons of trash mulch versus conventional methods.

Crop and field	Method	Yield-bushels per acre
Oats		
C-15.............	Trash mulch (deep furrow drill).................	No yield obtained*
C-16.............	Conventional.............	**12
Barley		
3B (North).......	Trash mulch..............	19
5B...............	Conventional.............	20
5C...............	Conventional.............	19
Wheat		
L-2..............	Trash mulch..............	14
L-3..............	Conventional.............	13

*Heads were very light. Lodging was severe. No significant yield was recovered. Roughness from deep furrow drill rows may have been a factor preventing harvest.

**Probably no better than C-15, but harvested first and the ground was somewhat smoother.

Texas

MULCH HELPS TO ESTABLISH GRASS ON SANDY SOILS

William C. Moldenhauer, Big Spring.--This is a preliminary report on a project on "climatic conditions necessary to establish grass for cover on sandy soils of the Southern High Plains."

.This experiment was designed to study the effect of a mulch, of high and low water levels, and of subsequent waterings on establishment of six different grasses--side-oats grama, blue panic, sand bluestem, blue buffelgrass, weeping lovegrass, and Blackwell switchgrass. The trial was carried out in tanks buried in the gound and filled to a depth of 9 inches with the soil from the site where they were buried.

Results:

1. Mulched plots (2 tons per acre of chopped sorghum) yielded significantly higher than corresponding non-mulched plots in every case.
2. High initial moisutre (1.25 inches moisture) unmulched treatments were not significantly higher than a treatment having low initial moisture (0.5 inch water), mulch, and third day watering (0.25 inch).
3. Low initial moisture treatment without mulch had practically no emergence.
4. Subsequent waterings did not give a consistent response on the high initial soil moisture treatments under mulch. With no mulch, the third day watering was highest, the sixth day watering next, and no subsequent watering was lowest. This latter situation occurred on the low initial moisture mulched treatments.
5. Sand bluestem did not germinate well under any treatment. It did respond somewhat to subsequent waterings, however.
6. Blue buffelgrass did not do as well as the other grasses (except sand bluestem) under the low initial soil moisture treatments.
7. Blue panic, sand bluestem, blue buffelgrass, and weeping lovegrass all responded to subsequent watering on the low initial moisture plots. Sideoats grama and Blackwell switchgrass did not.

Conclusions:

1. Protection from blowing sand is extremely important in grass establishment. A good cover crop is one of the best ways of supplying needed residue for surface protection during the seeding period.
2. A mulch covering the seed is not essential for germination if a rain of over 1 inch occurs. (This is under April and May temperatures). A mulch is essential if grass is to germinate on a 1/2 inch shower.
3. Subsequent light watering on the third day was very helpful on low moisture treatments. It was essential for blue buffelgrass under this treatment. On high initial moisture treatments with no mulch, both subsequent waterings were helpful but were essential only for sand bluestem.

MOISTURE CONSERVATION

Kansas

PASTURE BURNING CAUSES INEFFICIENT SOIL MOISTURE STORAGE

R. J. Hanks and F. C. Thorp, Manhattan.--Experiments at Manhattan, Kansas, have shown that the common practice of pasture burning has resulted in lower soil moisture storage and lower yields. The results further indicate: The longer the interval between burning and the reestablishment of plant cover, the lower the amount of moisture stored. The results are summarized in the following table. Moisture determinations were made in the spring of 1955.

Time of burning	Total soil moisture content (inches of water)				Relative moisture content of total 0-5 foot depth	Yields per acre average of 1944, 1950, 1953-1954
	0-1 foot	1-2 foot	2-5 foot	Total 0-5 foot		
	Inches	*Inches*	*Inches*	*Inches*	*Index*	*Tons*
No burning...........	4.02	3.65	8.43	16.01	1.00	1.48
Late spring...........	3.72	3.48	7.05	14.25	0.89	1.46
Mid spring............	3.19	2.84	6.16	12.19	0.76	1.36
Early spring..........	3.18	2.71	5.23	11.12	0.69	1.33
December..............	3.04	2.28	4.98	10.30	0.64	1.28

This more efficient soil moisture storage when plant cover is maintained for longer periods of time in the year is probably the result of a reduction in runoff and evaporation from the soil. There is some indication that burning also causes a deterioration of soil structure. Further investigations are underway to gain a better understanding of the basic causes for the results shown by these data.

Kansas

GRAIN SORGHUMS RESPOND TO STORED MOISTURE AT SEEDING TIME

Paul L. Brown, Hays.--Average yields of grain sorghum in 1954 from plots with 3 depths of stored moisture at seeding time were as follows:

Stored soil moisture depths	Yields per acre	Average water use
Feet	*Bushels*	*Inches*
3	21.0	12.08
5	35.5	15.00
7	48.2	17.01

This was not an irrigation experiment. Irrigation was used only to establish soil moisture levels prior to planting the crop. The 3-foot moisture depth was the result of natural precipitation. The 5-foot and 7-foot moisture depths were established by flood irrigation with 4 and 8 inches of water, respectively. The plots were 10 feet by 21 feet and the land was essentially level so that water distribution was uniform.

The soil was Hall silt loam and contains approximately 2 inches of available water per foot depth at field capacity. The rainfall during the growing season was 6.44 inches. Soil moisture samples were taken at planting time and at maturity.

As shown in the table, the 5-foot moisture plots used 3 inches more water than the 3-foot moisture plots and produced an average of 14.5 bushels more grain per acre. Each additional inch of water produced 4.8 bushels of grain.

The 7-foot moisture plots used 2 inches more water than the 5-foot moisture plots and produced 12.7 bushels more grain per acre. Each additional inch of water produced 6.3 bushels of grain in this case.

Nebraska

SUBSOIL MOISTURE MAY BE DIFFICULT TO STORE DURING SUMMER

F. L. Duley, T. M. McCalla, and R. E. Luebs, Lincoln.--If the early part of the season is dry, it may be difficult to store much moisture in the soil profile during the summer months under the climatic conditions in the Great Plains. This is due to the fact that although rainfall may be higher than at other times during the year, evaporation is also higher. The high rate of evaporation may dissipate the soil moisture after each rain, leaving the soil dry for the next rain. Three years' results during seasons of low rainfall show that under certain conditions of the surface there may be little or no gain from April to September while with other surface treatments there may be considerable accumulation.

Results in the table that follows show the surface inches of water stored in the top six feet of soil from the first of April through September each year 1939-41; the amount of rainfall during this period for each year is also shown. It will be seen that only a small percent of the rainfall was stored in the soil under these conditions as gain at wheat seeding time in the fall over what was present in the soil in the spring.

In more favorable years, with the use of favorable treatments it is usually possible to make material gains in soil moisture during the season.

Soil moisture storage in fallowed land during the period April-September
for the years 1939, 1940, and 1941

Straw application per acre	Tillage	Surface water stored in 6 feet of soil			
		1939	1940	1941	Mean 1939-1941
Tons		*Inches*	*Inches*	*Inches*	*Inches*
1...............	Subtilled..............	1.19	0.77	-.28	0.56
2...............	"	2.29	1.91	1.19	1.80
4...............	"	3.78	3.11	1.51	2.80
8...............	Weeds pulled...........	5.34	3.75	4.21	4.43
2...............	Disked.................	1.29	0.04	-.43	.30
2...............	Plowed.................	0.34	0.64	.25	.41
2*..............	Subtilled..............	0.03	-0.62	-.73	-.44
None............	Disked.................	0.72	-0.14	.05	.21
None............	Plowed.................	0.24	-0.39	-.23	-.13
None............	Basin listed...........	1.43	2.47	.26	1.39

*Decayed straw

Rainfall

Total		April to September
1939	20.95	14.68
1940	24.18	15.07
1941	25.50	15.87

California

RAINFALL PENETRATION BELOW ROOT ZONE VARIES WIDELY

Harry F. Blaney, Los Angeles.--In southern California subnormal precipitation and an increasing demand for water from underground supplies in soil and water conservation districts for irrigation and other purposes has created a need for more accurate data on evapo-transpiration by irrigated crops and native vegetation and on the contributions of rainfall on valley floors to ground-water supplies. Information on these and other factors that combine in disposing of rainfall are essential when making an inventory to determine the adequacy of a water supply for a district.

Some years ago studies were made of rainfall penetration to ground water by taking soil samples before and after rainfall to a depth below the root zone at stations established on predominating soil types and vegetative cover. The results of these studies in the Santa Ana River Basin showed deep penetration below the root zone for grass cover after 10 to 12 inches of seasonal rain had fallen. For denser grass and weeds, 12 to 15 inches of rainfall was necessary before deep penetration occurred. A seasonal precipitation of at least 19 inches was necessary before any material amount of water penetrated below the brush root zone on the valley floors. Penetration in the winter-irrigated areas was dependent largely on the time and amount of irrigation, and for citrus plots it ranged from 5.9 inches for rainfall of 15.6 inches to 6.6 inches for rainfall of 18.7 inches. Unirrigated deciduous trees and vineyards showed root activity to a depth of 15 to 18 feet with a capacity of 18 inches of rain without deep penetration below the root zone.

Experiments made at 16 locations in Ventura County show that penetration of rain water below the root zone may occur in bare land and irrigated areas where less than 10 inches of rain has fallen. Most of the precipitation in these areas occurs during the cool

winter months when the rates of evaporation and transpiration are at a minimum. The following tabulation gives a summary of the results of these studies:

Rainfall penetration below root zone, associated with seasonal rainfall, land use and irrigation, Ventura County, Calif.

Seasonal rainfall	Rainfall penetration below root zone where land use is--							
	Citrus, irrigated just prior to rains		Citrus irrigated --usual practice		Deciduous, irrigated	Beans, irrigated	Brush, dense weeds, and grass	Bare land
	Clean cultivated	Cover cropped	Clean cultivated	Cover cropped	Clean cultivated	Clean cultivated		
Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
9.90	1.1	1.1	0.0	0.0	0.0	0.6	0.0	1.5
10.44	1.4	1.4	.0	.0	.0	1.9	.0	2.9
11.93	1.1	1.1	.0	.0	.0	2.5	.0	3.5
13.09	2.3	1.6	.5	.0	.0	2.9	.0	3.9
14.36	3.1	1.6	1.1	.0	.0	4.8	.0	5.8
15.42	3.9	2.0	1.9	.1	.2	5.9	.0	6.9

TILLAGE AND CULTURAL PRACTICES

Louisiana

DEEP TILLAGE CONTROLS "HOT SPOTS" IN COTTON FIELDS

I. L. Saveson, Z. F. Lund, Baton Rouge.--In many of the cotton producing areas of the Mississippi Delta, and particularly of Louisiana, streaks on small areas of cotton will suffer severe drouth damage if there is any degree of moisture stress during the growing season. These drouth-susceptible spots are locally called "hot spots". Preliminary studies indicated they were usually associated with areas having compacted zones in the upper soil profile. Studies of tillage practices to remove or control this condition are now under way at the Northeast Louisiana Experiment Station at St. Joseph.

The conventional method of plowing and the three methods of deep tillage under test to control compaction in the Delta Section of Louisiana on cotton land are listed as follows:

1. Conventional turn plow approximately 5 inches deep, plus ordering (final seedbed preparation).

2. Edging by deep plowing 18 inches deep, setting furrow slice on edge.

3. Lifting subsurface tillage with tool bar and sweeps 18 to 24 inches deep, depending on location of compacted layer of test area site, plus ordering.

4. Mixing by scarifying, using Graham Hoeme plow to depth of approximately 14 inches deep to secure maximum mixing of soil, plus ordering.

Yield results are shown in the following table.

The deep tillage work on this test was done the first of December, 1953, which gave the land an opportunity to store up water from the winter and spring rains. (The prior two years had severe droughts.) In working the area, the hot spots or compacted zones were found in streaks or bands diagonally across the field, ranging from 20 to 40 feet in width and approximately 100 feet apart. They were extremely hard.

Cotton yields in tillage tests on Commerce silt loam, Northeast Louisiana Experiment Station, St. Joseph, 1954

Treatment	Yield per acre	
	Seed cotton	Lint cotton
	Pounds	*Pounds*
(1) Mixed by scarifying (Graham Hoeme)	1,817	666.8
(2) Turned and edged. 8" in fall, 13 1/2" in spring	2,614	959.3
(3) Lifted, fall 1953. 18" deep, 18" sweeps, 1 level	2,857	1,048.5
(4) Conventional middle buster	2,022	742.1

Moisture observations during the early spring (first of April) at 3 feet revealed that the earth was too dry to remove from the auger holes in the conventional plots, whereas, in the deep-tilled plots (by lifting) a saturated soil was found.

Moisture determinations on May 17, when the cotton was in the two-leaf stage, show that subsoil moisture on the conventional plots was considerably lower than on the deep-tilled plots.

During the hot dry period from July 23 to August 25 the cotton burned badly on the conventional and mixed plots (scarified).

Studies by Jamison and Domby showed a hydraulic conductivity of .32 inches per hour for the lifted (subsoiled) plots against .07 per hour for the conventional plots. Bulk density of the lifted plots was 1.37 grams per centimeter against 1.48 grams per centimeter on the conventional plots; the lower density should permit the soil to store more of the winter rainfall. Their studies also indicate a high available water-holding capacity of these soils where they are not distressed by compaction. Over 50% of the water held by the soil is available to plants.

Yields and moisture determinations of outfield experiments on a larger scale test on Commerce silt loam at Wilkerson Plantation, Newellton, Louisiana, worked in the spring (March 1954), followed very closely the results of the plots at St. Joseph, Louisiana, with a lesser increase in yields; the lifted plots yielding 907 pounds of lint cotton, an increase of 181 pounds over the conventional plots; the edged plots yielding 886 pounds per acre, an increase of 160 pounds of lint cotton; the mixed plots showed an increase of 42 pounds of lint cotton, while at the Northeast Louisiana Experiment Station they showed a decrease.

Montana

LISTER-TYPE DRILLS BEST IN HEAVY TRASH FALLOW

J. L. Krall and R. M. Williams, Moccasin.--Three basic drill designs--lister, disk and blade--were tested for seeding winter wheat into heavy trash fallow (2,000 to 3,000 pounds of straw per acre) over a five year period. The results as shown in the table that follows indicate there is a slight advantage in the lister-type opener. The ordinary drill with 10 inch disks, with six-inch spacing, was not satisfactory for seeding into heavy trash. Not only were the yields reduced, but considerable "plugging" occurred during the seeding operations.

It was concluded that when fall moisture is adequate, any deep furrow drill will give satisfactory stands of winter wheat under our conditions. However, when fall moisture is limited, as in the fall of 1953, better stands and yields can be obtained from lister-type

openers which have a tendency to move more efficiently through the trash and place more of the seed into the moist soil. From the standpoint of ease of operation and less "plugging", the blade drill, followed by the lister and the 18-inch disk, was most satisfactory.

Five-year summary of average yields of winter wheat from drill tests conducted under trash fallow conditions at Moccasin, Montana

Drill type		Yields per acre					
Opener	Spacing	1950	1951	1952	1953	1954	5-year average
		Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Lister........	14 inch.......	37.5	18.1	19.3	28.4	24.0	25.4
Blade.........	10 inch.......	37.2	18.8	15.9	29.4	22.3	24.7
18" Disk......	12 inch.......	36.0	18.3	17.1	29.9	22.3	24.7
10" Disk......	6 inch.......	32.1	17.8	15.7	18.7	19.9	20.9

SOIL AND WATER MANAGEMENT--GENERAL

Georgia

ECONOMIC PROBLEMS SHOW UP IN FARM UNIT STUDY AT WATKINSVILLE

John R. Carreker, Athens--Conservation practices being tested under farm conditions at the Southern Piedmont Conservation Experiment Station are proving to be effective in controlling runoff and erosion but leave some economic problems unanswered.

A farm unit study at this station was started in 1941 to test under farm conditions certain practices being studied on plots elsewhere on the station.

Facts about the farm and the study follow.

The farm unit. Size: 100 acres. (Average in 1940 in the surrounding Oconee River Soil Conservation District was 81.2 and in Georgia as a whole 109.6).

Land: Classes I through V, representative of the area; open land, 80 acres; woods, farmstead and roads, 20 acres.

Treatment and management. In 1941 all cropped fields were terraced and waterways were established. Proper crop rotations were established; the steeper slopes and pasture areas were devoted to perennial sod.

First cropping system: On Class I land, corn with crotalaria continuously; on Classes II and III land, 2-year and 3-year rotations with small grains, Kobe lespedeza and cotton or corn.

In 1943 a small herd of beef-type cows was added. In 1944 when a market for ungraded milk was established, dairy cows were substituted.

Changes in cropping: In 1947 continuous corn was eliminated because of poor yields (open-pollinated varieties and inadequate nitrogen were used); the 2-year and 3-year rotations were rearranged by fields to include the Class I land. In 1952 and 1953 the small grain and lespedeza combination was replaced with perennial grasses and clovers. On Class I land, rescue grass and button clover were used in a 2-year rotation with corn and grain sorghum. On Classes II and III land, fescue, crimson clover and ladino clover were used in a 3-year rotation. Oats were seeded with the grass and clovers after the row crops each year.

Machinery: Power was supplied through 1947 by mules and hired tractors. In 1948 the farm was mechanized with modern equipment furnished by the Agricultural Engineering Department of the College of Agriculture. This included a 1-row 18 horsepower tractor, a 2-disc plow, 2 disc harrows, combination row crop planter-fertilizer distributor-cultivator, mower, side delivery rake, grain drill, broadcast fertilizer distributor, and wagon. A hay baler and combine harvester have been hired as needed.

Returns. The gross income has been derived mainly from cotton and milk. Some grain, lespedeza seed, hay and cows have been sold. Beginning with 1945, income from livestock and livestock products have about equalled returns from crops. Weather has had far more effect on annual income from crops than from livestock. Income from milk and cattle sales was nearly uniform each year regardless of weather.

The highest gross income was $5,961 in 1951. That was also the year of the highest net income, $4,095. Net income was down to $1,133 in 1954.

Gross income declined during 1952-54 for four main reasons: (1) severe summer droughts; (2) infestation of weeds that reduced yields of sericea lespedeza hay and seed; (3) change in cropping from small grain-Kobe lespedeza to grass and clover on the rotated land, which reduced the amount of crops for sale without a corresponding increase in milk flow; (4) decline in prices of products sold.

Costs were increased heavily in 1952 by the initiation of new cropping practices, the construction of more fences, and an increase in hauling distance for milk due to loss of the local market. Some of the increase in costs has continued, although expenses in 1954 were down to about the level of 1946-47.

Table 1 that follows gives the financial record by years. This record does not include the value of food and feed consumed on the farm, nor the value of rent for the homestead.

TABLE 1.--Gross income, expenses and net income of 100-acre farm unit at Southern Piedmont Conservation Experiment Station, Watkinsville, Georgia, 1941-54

Year	Gross income	Expenses	Net income
	Dollars	Dollars	Dollars
1941	1,952	936	1,016
1942	2,561	964	1,597
1943	3,035	1,649	1,386
1944	3,329	1,594	1,735
1945	4,263	2,366	1,897
1946	5,018	2,458	2,560
1947	4,701	2,469	1,931
1948	5,805	1,923	3,317
1949	5,627	1,780	3,841
1950	5,119	1,777	2,930
1951	5,961	1,757	4,095
1952	5,205	3,329	1,109
1953	4,943	2,956	2,503
1954	4,212	2,483	1,133

Data from commercial family-operated cotton farmers in the Southern Piedmont, given in Table 2, show that expenses on our farm were fairly comparable to the average for this area prior to 1952. The gross receipts and net returns were much higher on our farm than on the average for the Southern Piedmont, however. The addition of dairy cows to utilize the forage crops in the conservation treatments increased both the gross and net receipts.

TABLE 2.--Commercial family-operated cotton farms in the Southern Piedmont*--cash receipts and expenditures, net cash and net farm income, 1947-1954

Year	Total cash receipts	Total cash expenditures	Net cash income	Net farm income**
	Dollars	Dollars	Dollars	Dollars
1947-49.........	2,827	1,908	921	1,566
1950............	2,378	1,700	678	1,208
1951............	3,243	2,058	1,185	1,982
1952............	2,784	1,987	797	1,596
1953............	2,629	1,963	666	1,340
1954............	2,040	1,653	387	994

*Data from Production Economics Research Branch--1954 data in publication being processed at time of preparation of this report.
**Differs from net cash income by including inventory changes and value of home-produced, home-consumed food.

Conclusions.

1. Terracing and proper cropping treatments on sloping Piedmont land gave excellent runoff and erosion control.
2. Crop yields were consistently higher on this farm than the average for the local county.
3. Livestock were a necessary part of the farm operation, utilizing the forage crops in the conservation cropping treatments.
4. Mechanization aided in establishing and maintaining conservation cropping treatments.
5. Conservation-type crops must be selected for revenue benefits as well as for control of runoff and erosion.
6. More intensive cropping, more land, more efficiency, less cost, or a combination of these will be required if returns are to be adequate on this farm in the future.

Puerto Rico

DAIRY HEIFERS RAISED ON KUDZU-GRASS PASTURES, STEEP SLOPES

J. Vicente-Chandler, Rio Piedras.--Ten Holstein heifers were grazed for a year on a ten-acre Kudzu-grass pasture in the mountain region of Puerto Rico. The soil is shallow, eroded, Mucara clay on 50 percent slopes. The heifers received no concentrate feed.

The gain in weight made by the different heifers is shown in the table. On the average, the heifers weighed 266 pounds when put on the pastures and 728 pounds when the trials were concluded. They thus gained an average of 462 pounds per head over a one-year period. At the end of the trials, the heifers weighed only 12 percent less than purebred Holstein heifers of the same age raised on concentrates and high quality hay should weigh in the United States according to Morrison's standards.

This experiment shows that high quality dairy heifers can be raised without concentrate feeds on Kudzu-grass pastures growing on steep, eroded soils in the mountain region of Puerto Rico. This is much more economical than raising these animals on concentrates and cut feed in the coastal areas where most of the dairies are located. It is probable that in the future the mountain region of Puerto Rico will raise most of the heifers needed by the dairies of the Island.

Gain in weight of 10 Holstein heifers over a one-year period when grazed on a Kudzu-grass pasture on 50 percent slopes of shallow, eroded soil in the mountain region of Puerto Rico. The heifers received no feed other than that obtained from the pastures.

Heifer No.	Initial weight	Final weight	Total gain in weight	Average daily gain
	Pounds	*Pounds*	*Pounds*	*Pounds*
1	295	800	505	1.1
2	155	768	613	1.7
3	289	825	536	1.5
4	246	690	444	1.2
5	164	565	401	1.1
6	204	658	454	1.3
7	341	680	339	.9
8	410	810	400	1.1
9	204	654	450	1.3
10	355	831	476	1.3
Average	266	728	462	1.24

Florida

SWEET PEPPERS DO POORLY FOLLOWING SORGHUM

J. C. Stephens, Fort Lauderdale. --Full-season yields and water use by sweet peppers grown in tank lysimeters of sandy soil essentially confirm tentative conclusions based on a portion of the growing season and given in Quarterly Report No. 4. Much lower yields and inferior produce were obtained from lysimeter tanks 1 through 6 following sorghum. There was no noticeable difference in bedded versus flat cultivation. In the early stages of growth the pepper plants did best with high water tables--12 inches; however, as the plants matured and fruited the 24-inch depth gave highest yields and quality. This suggests the advantage of beginning with a 12-inch water table and gradually lowering it as the plants develop.

Daily water use for each lysimeter was determined by balancing the hydrologic equation. Crop use was compared with evaporation from the Weather Bureau standard evaporation pan. In these studies the water consumption includes soil evaporation and plant transpiration. It was found that water consumption was increased by dense stands, by plant growth up to maturity, high temperatures, and longer daylight hours. It was decreased by cloudy weather, rains, and high humidity. The maximum daily use of mature healthy peppers was approximately 0.24-inch when growing at a 12-inch depth water table; 0.20-inch when growing at the 18-inch level; and 0.19-inch when growing at the 24-inch level. The increased use of water in the lysimeters with high water tables probably reflects an increase in soil evaporation rather than an increase in plant transpiration. It has been found that evaporation losses in fallow tanks increased when the water table was maintained close to the surface. With the water table 12 inches below land surface, the evaporation loss from bare soil was approximately the same as from the surface of a lake; when 24 inches deep, about 60 percent; and when 36 inches deep, about 20 percent.

Under south Florida conditions root diseases, such as Pythium, are important in determining vegetable crop yields and quality. From the lysimeter studies, it appears that the different soil moisture conditions, by influencing the ecology of the soil microorganisms, contribute in a large degree to the success of the crop, at least until the soil moisture decreases to near the wilting point.

Twelve lysimeters, each .001-acre in size, are used in this experiment.

Plantation Field Laboratory, Fort Lauderdale, Florida, water consumption data from lysimeters planted to sweet pepper plants*, which are grown at controlled water levels

Tank No. and type of cultivation**	Depth to water table from ave. ground surface	Moisture equivalent of soil	Average soil moisture in root zone (0-6")	Average soil tension (cm. of H_2O) at 6" root zone	Water consumption	Ratio of water consumption to stand. pan evaporation	Relative market value of produce***
1st Series (following sorghum)							
	Inches	*Percent*	*Percent*	*Centimeter*	*Inches*	*Ratio*	*Index*
1 - F	12	3.40	19.1	15	24.6	0.76	6.3
2 - B	12	3.55	17.8	20	25.2	.78	8.5
3 - B	18	3.54	12.1	46	18.9	.59	9.6
4 - F	18	3.43	10.7	54	16.2	.50	4.4
5 - F	24	3.61	8.2	64	14.8	.46	13.5
6 - B	24	3.30	8.9	61	14.5	.45	12.2
2nd Series (virgin soil)							
7 - B	12	3.65	19.5	12	27.9	.86	24.6
8 - F	12	—	19.4	12	28.1	.87	25.2
9 - F	18	3.44	13.5	39	22.3	.69	24.8
10 - B	18	3.45	11.8	48	22.3	.69	26.4
11 - B	24	3.48	8.4	63	18.1	.56	29.6
12 - F	24	3.41	9.2	59	19.7	.61	30.9

*Plants set Oct. 16, 1954, cut May 2, 1955.

**F - Planted on the flat with no bedding; B - planted on beds.

***The relative market value of produce for each tank is the sum of the products of the weight of each grade--i.e., Fancy, # 1, and # 2 times its relative value at the State Farmer's Market.

Texas

BROADCAST SEEDING BEHIND DRILL GIVES GOOD STAND OF SWEETCLOVER

R. M. Smith, Temple.--Sweetclover stand counts summarized in the table that follows suggest that broadcast seedings behind a deep furrow drill gave stands that are equal or superior to stands obtained by the conventional method of dropping seed in a band immediately behind and above the small grain row.

With broadcast seeding at this location, the hazards to establishment of young seedlings may be spread out more than with banding. Light fall showers followed by hot dry periods killed many seedlings in the fields represented. The same has been true for several years. Young plants also suffered and some died during the dry weather of March and April when competition from small grain was severe.

One major reason for band seeding in this area has been protection from winter killing. In the past it has been observed that clover seedlings in the row may resist cold better than seedlings between rows. Closeness to the banded phosphate fertilizer and protection by the small grain have been suggested as reasons for this resistance to cold.

During recent years drouth and heat are believed to have been more frequent and more damaging factors than cold.

Sweetclover stands obtained by three methods in field areas fall planted on several dates (seed was non-scarified)

Seeding method	Number of fields	Average* clover plants per sq. ft. by seeding dates					
		Dec. 14	Jan. 25	Mar. 2	Apr. 26	June 15	All-dates average
Conventional, seed banded	4	4.1	4.0	4.7	3.5	2.9	3.8 (the range for different fields was 1.5 to 7.1)
Deep furrow--trash mulch seed broadcast.........	5	5.6	9.2	7.4	5.3	3.3	6.2 (the range was 2.4 to 8.7)
Deep furrowed--no seed[1]..	7	7.4	21.0	13.6	11.3	7.6	12.2 (the range was 3.9 to 23.2)

*Averages are from 10 counts in each field on each date.
[1] These fields with no seed were deep-furrow drilled following small grain with sweetclover. Stands are mostly volunteer from shattered seed, with a few second-year plants that escaped root rot.

Results during the past 3 years tend to support the idea that in this area, spreading the risk with broadcast seedings of non-scarified sweetclover may provide at least as many advantages as banding. This may be true for cold damage as well as for heat and drouth damage, although data are lacking. More years of counts are needed before final conclusions are reached.

Nebraska

STRAW, STOVER YIELDS MAY BE ESTIMATED FROM GRAIN YIELDS

R. E. Ramig, North Platte.--Data at the North Platte Station indicate that reliable estimates of straw and stover yield can be made from grain yields whenever grain yields exceed about 8 bushels per acre. Whenever yields are lower than approximately 8 bushels per acre, the stover or straw production for each bushel of grain produced increases sharply above the average figures given in the accompanying table.

Winter wheat, spring wheat, spring barley, oats, corn, and grain sorghum were continuously cropped on a series of plots from 1937-1947. Early plowing, late plowing, late summer or fall listing, and alternate crop-fallow were the moisture conserving tillage practices studied for all crops except grain sorghum for which fall listing as a tillage preparation was omitted. The amounts of straw or stover produced per bushel of grain usually did not vary more than twenty pounds from the 11-year average figures given in the table except when yields were very low. For example, a wheat yield of 2.5 bushels per acre in 1944 required a straw production of 460 pounds per bushel of grain. Similarly, a corn yield of 6.6 bushels per acre in 1942 had a stover production of 177 pounds per bushel of corn. However, when grain yields of all crops exceeded 10 bushels per acre, the stover or straw production per bushel of grain was very near average figures.

The average annual precipitation at North Platte is 19.24 inches, and the soil is Holdrege very fine sandy loam. It is thought that field men in western Kansas and Nebraska and eastern Colorado could use the figures herein reported to make sound estimates of the amounts of straw or stover residue on the land after the crop has been

removed by combining or picking. For example, if a field of winter wheat had yielded 30 bushels per acre, the straw or above-ground residue production could be estimated to be 30 x 100 pounds of straw per bushel of grain or 3,000 pounds of straw per acre.

Average yields of straw or stover per bushel of grain produced in continuously cropped rotations at North Platte, 1937-1947

Crop and variety[1]	Yield of straw or stover where land was--			
	Late plowed	Early plowed	Fall listed	After fallow
	Pounds	*Pounds*	*Pounds*	*Pounds*
W. Wheat-Cheyenne................	96	93	94	112
S. Wheat-Ceres....................	126	139	130	156
S. Barley-Comfort-Spartan[1].......	58	55	51	63
Oats-Nebr. 21-Brunker[2]..........	31	34	37	40
Corn-SS White....................	103	101	105	100
Sorghum-Early Kalo..............	133	134	---	120

[1] Comfort variety 1937-43; Spartan 1944-47.
[2] Nebraska 21 in 1937; Brunker 1938-47.

Although the figures reported here are from continuously cropped moisture conservation plots, they are not significantly different from similar values for the same crops grown in 2, 4, 5, or 6 year rotations with other crops.

Wyoming

WINTER DROUGHT KILLS ALFALFA, RED CLOVER, ORCHARD GRASS

Rulon D. Lewis, Laramie.--At Powell, Wyoming, many acres of alfalfa and some acreage of red clover were winter-killed because of drought during the winter 1954-55, resulting in many acres being plowed up. Also, orchard grass was winter-killed at Powell and Pinedale.

Arizona

CANNING PEAS PRODUCE WELL ON THE YUMA MESA

Joseph Hamilton and Marlowe D. Bigler, Yuma.--Earlier favorable results with market and freezer varieties of peas have now been confirmed. The Wando variety was consistently the highest yielder in earlier tests. Now, two later maturing, ranker growing strains of Perfection (No. 25 and W. R.) have yielded as well or better. Early Perfection and Cascade may fit into a production program to extend the harvest season but appear to have a lower yield potential. Surprise and similar varieties appear to lack the necessary vegetative vigor.

Early planting (November 20) will commonly receive frost damage to blossoms and yield less than December 10-January 10. Planting as late as January 20 again yielded less due to high temperature damage to the immature pods. Yield data are presented in table 1.

TABLE 1.--English peas. Yields of six varieties shelled peas (pounds per acre) by planting dates. Yuma Mesa, Arizona, 1954-55

Variety	Yields per acre when planting date was--				
	Nov. 20	Dec. 10	Dec. 30	Jan. 20	Mean
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Surprise	544	586	1,464	1,806	1,100
Early Perfection	413	1,316	4,215	3,658	2,400
Cascade	1,601	2,852	4,861	4,111	3,356
No. 25 Perfection	2,986	5,908	5,722	3,534	4,538
W. R. Perfection	2,519	4,714	5,631	4,107	4,243
Wando	2,223	6,154	5,212	3,228	4,204
Mean	1,714	3,588	4,518	3,407	3,307

Least significant differences at level of:	.05	.01
Between 2 variety means (rt. margin)	332	441
Between 2 planting date means (lower margin)	558	801
Between 2 varieties with the same planting date	664	883
Between 2 planting dates for same variety	822	1,131

The maintenance of rather high soil moisture level is essential for satisfactory yields of market peas on the Yuma Mesa.

Phosphate, banded in close proximity to the seed at planting, doubled the yield at the high moisture level and gave a lesser response under drier treatments. Data from varying moisture and fertilizer treatments are presented in table 2.

TABLE 2.--Effects of irrigation and phosphate on yields per acre of shelled peas Cascade variety, Yuma Mesa, Arizona, 1954-55

Irrigation[1]	Yields per acre where phosphate application per acre was--					
	0	50	100	100[2]	200	Mean
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Wet (13 irrigations, under 200 cm.)	2,004	3,738	3,919	4,288	4,258	3,641
Medium (7 irrigations, under 600 cm.)	1,406	2,096	2,190	2,160	2,401	2,051
Dry (3 irrigations, under 600 cm. 2/3 of time)	866	1,393	1,289	1,248	1,333	1,226
Mean	1,426	2,409	2,466	2,565	2,664	2,306

See footnotes at end of table.

TABLE 2.—Continued

Least significant differences at levels of:	.05	.01
Between 2 moisture means (rt. margin)	---	794
Between 2 phosphate means (lower margin)	345	463
Between 2 phosphate treatments at the same moisture level	598	803
Between 2 moisture treatments at the same phosphate level	746	1,058

[1] Tension at 6-inch depth and number of irrigations after Jan. 20. Between Dec. 14 and Jan. 20, inclusive, four irrigations were applied uniformly to all treatments.
[2] 100 pounds N per acre broadcast soon after planting.

Summary:

These experiments show that satisfactory yields of certain varieties of market peas may be produced on the Yuma Mesa by:

(1) planting late enough to avoid frost damage to the blossoms;

(2) banding phosphate with the seed;

(3) maintaining a high soil moisture level by frequent irrigations.

HYDROLOGY--GENERAL

Ohio

MINIMUM WATER YIELDS ARE RELATED TO SIZE OF WATERSHED

F. R. Dreibelbis and L. L. Harrold, Coshocton.--Water yield in this region is influenced by the size of the drainage basin. This is illustrated in the following table:

Mean daily stream flow (cfs), minimum for a 5-day period in June, July, and August, 1938-54

Area (acres)	Order No.*	June	July	August
920	1	0.01	0	0
	2	.03	.024	0
	3	.04	.03	0
2,569	1	.03	0	0
	2	.06	.03	0
	3	.09	.03	0
4,581	1	.054	.003	.005
	2	.12	.01	.007
	3	.19	.03	.007
17,540	1	.6	.1	.1
	2	1.6	.2	.1
	3	1.8	1.0	.2

*Lowest = 1; next lowest = 2; etc.

These data are valuable in planning for the pumpage of stream flow for irrigation water supply.

Minimum flow for periods of one or more consecutive months also appears to be influenced by size of drainage area as illustrated in the following table.

Minimum water yield (inches) for periods of 1 to 6 months, 1938-54

Area (acres)	Order No.	Water yield in period of--			
		1 month	2 months	4 months	6 months
349	1	0.0029	0.0058	0.02	0.10
	2	.01	.02	.04	.18
	3	.01	.02	.07	.49
4,581	1	.0007	.0027	.02	.13
	2	.0016	.02	.07	.29
	3	.0039	.03	.09	.46
17,540	1	.005	.01	.07	.29
	2	.006	.04	.12	.38
	3	.009	.06	.19	.53

In general, water yield values increase with size of drainage area--at least up to 17,540 acres. For single-month or 2-month periods, the water-yield values for the 349-acre area appear to be out of line.

Wisconsin

UNUSUAL PEAK DISCHARGES FROM WISCONSIN WATERSHEDS REPORTED

N. E. Minshall, Madison.--On June 2, 4.5 inches of rain fell in a 4-hour period at Black River Falls in west-central Wisconsin. This occurred on soil already wet from previous rains and caused severe erosion and local flooding. Estimates of flood peaks produced by this storm were made from high water marks on a few small areas and the results are given below.

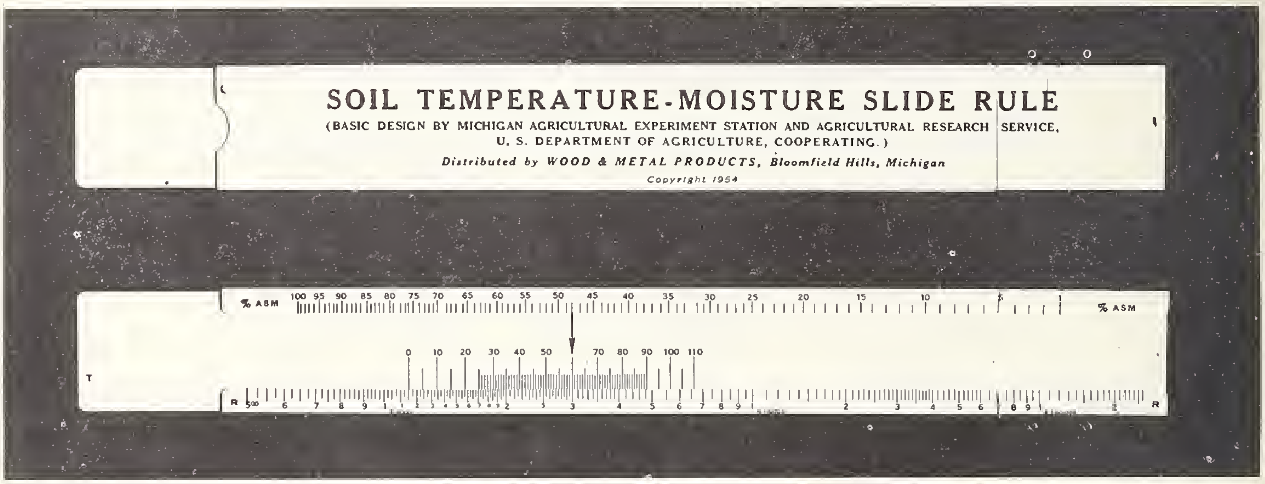
Type of control	Drainage area	Estimated peak discharge
	Acres	*C.f.s.*
Drop inlet........	140	290
Box inlet.........	430	620
Box culvert.......	1,190	1,150
Bridge............	1,440	1,750

Michigan

SLIDE RULE DEVISED FOR SOIL MOISTURE STUDIES

G. A. Crabb, Jr., East Lansing.--A special-purpose slide rule (see illustration) has been developed to correct observed electrical resistances of soil moisture blocks for soil temperature and to convert the corrected resistance reading to percent available soil moisture. The device quickly and correctly makes this conversion, which has long been a cumbersome aspect of the precise utilization of the electrical resistance method of soil moisture determination. It is now in commercial production in a rugged and simple form,

compact and highly legible. The use of this rule offers considerable savings in time and money, especially where a large number of moisture blocks are under observation. Rules are available from the distributor: Industrial Instruments, Inc., 89 Commerce Road, Cedar Grove, New Jersey, and from irrigation equipment supply houses.



HYDROLOGY--LAND USE INFLUENCES

Nebraska

CONTOURING CORN REDUCES WATERSHED RUNOFF

John A. Allis, Hastings.--Contoured corn land took an average of 36 percent (1.62 inches) more moisture per year for 14 years than did straight-row corn in a watershed approximately 4 acres in size, according to 1940-53 records at the Central Great Plains Experimental Watershed near Hastings. Average yearly runoff was 4.47 inches from corn planted in straight rows in a corn-oats-wheat rotation. On similar watersheds where the same machinery and farming practices were used, except that corn was planted and tilled on the contour, the average yearly runoff was 2.85 inches.

These watersheds were farmed as fields with conventional farming machinery and practices. In the straight-row farming, the directions of the rows were the same as had been previously used by the operator and in nearly all cases were across the slope.

The average slope of the watersheds is 5.1 percent. They are natural headwater areas and have a length-width ratio of 1:1.8. The loessial soils are of silt loam texture with moderately slow permeability and are representative of a large area in Nebraska and Kansas.

The average annual rainfall during the period of record, 1940-53, was 23.70 inches as compared to approximately 24 inches for the long-time period of record. The rainfall varied from 12.96 inches to 36.09 inches in the 14-year period, which is also fairly representative of the variations in the long-time period of record.

Both the highest annual rainfall and highest runoff were in 1951, the year of the Kansas River flood. The rainfall was 36.09 inches at the meteorological station, and there was an average runoff of 10.35 inches from straight-row corn as compared to an average of 6.56 inches from the contoured corn.

SEDIMENTATION

Mississippi

NO CHANGE IN DESIGN CRITERIA INDICATED BY RE-SURVEY OF DEBRIS BASIN

Russel Woodburn, State College.--A re-survey was made in May of a medium-size de-silting basin in the East Goose Creek valley near Oxford. It has a drainage area of 311 acres and was constructed in June 1953. Valley slope is .0052 below dam and .0068 above dam.

Rainfall was deficient by 12 inches for the last 6 months of 1953 and by 10 inches in 1954. Even so, sediment had accumulated in the 1.83 years in the amount of 5.66 acre-feet in the reservoir of which 4.28 acre-feet was below elevation of top of riser pipe and 1.38 acre-feet was in flood pool.

The calculated sediment deposition in the basin, using the Woodburn-Roehl sediment equation, was 10.0 acre-feet or considerably more than actually measured. If the watershed should produce sediment at its current rate for 10 years, the total volume would be 30.6 acre-feet. The calculated sediment production by the equation, which decreases with time for 10 years would be virtually the same or 30.9 acre-feet.

It was concluded that no recommendation should be made for reducing sediment design criteria, at least without considerably more field studies.

A re-survey was made of East Goose Creek valley for several miles below the dam discussed above. There was clear cut channel degradation in the reach from 300 feet below dam to 3,300 feet below dam. In this 3,000-foot reach, there was channel degradation in the amount of 3,100 cubic yards from August, 1954 to May, 1955. The bulk of this was caused by a heavy rain of March 21 and another April 12.

At a point 2 miles below the dam, some cutting of the channel was evident, but the trend of changes was not clear.

HYDRAULICS

Minnesota

LITTLE BENEFIT SEEN IN JOINING LATERAL TO MAIN AT 45-DEGREE ANGLE

F. W. Blaisdell, Minneapolis.--Tests have been completed on pipes flowing completely full where a lateral the same size as the main enters the main at an angle of 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, and 165 degrees. The junction was sharp-edged. The discharge from the lateral was varied in increments of 10 percent from zero to 100 percent of the combined flow in the main downstream from the junction. The velocity of flow in the downstream main ranged from 2 to 15 feet per second. The loss in energy caused by flow entering at the junction has been determined for both the lateral and the main.

Using the results of these tests, a section of a farm tile drainage system was computed to see what would be the effect of joining the lateral with the main at an angle of 90 degrees instead of at a 45-degree angle. For the particular conditions assumed, the maximum benefit in favor of the 45-degree entry angle was approximately 1/32-inch of head loss in 500 feet of main--an obviously insignificant amount.

The experiments are continuing with laterals smaller than the main.

STRAIGHT DROP SPILLWAY COEFFICIENTS ARE ON SAFE SIDE

C. A. Donnelly, Minneapolis. --In a series of tests to determine the effect of elevation of the approach channel floor on the coefficient of discharge in a straight drop spillway, it was learned that when the floor is level with the crest elevation the coefficient and, therefore, the discharge is the lowest. No tests were made with the approach floor above crest level. Since practically all field structures would have upstream deposition to the elevation of the crest, it was decided not to run further tests on the effect of the depth of the approach channel.

In order to determine the effect of the dike location on the discharge, a dike was used which had a 2-to-1 slope perpendicular to the channel centerline and a 3-to-1 slope parallel with the centerline. The toe of the dike was placed at distances of 0.75, 0.375 and 0.187 foot, and at 0.0 from the end of the spillway crest. This series of tests showed that the highest discharge coefficient was obtained when the toe of the dike was at the end of the crest.

In order to reduce the number of variables and with the hope that general laws applicable to dikes could be determined, the dikes were removed and vertical sidewalls were used with spillway crest lengths L of 0.375, 0.75, 1.0, 1.75, and 2.5 feet with a ratio of L/W_c from 0.0625 to 0.8, where W_c is the width of the approach channel.

The discharge coefficient C was computed using a number of formulas. In order to obtain a constant value of the discharge coefficient for any one test, it was necessary to correct for H_o--the apparent head of 0 discharge. When $Q^{2/3}$ is plotted as an ordinate and H, the specific head, as the abscissa, a straight line is obtained which does not go through the origin. The head at zero discharge is H_o. The equation for C is

$$C = \frac{Q}{L\ (H - H_o)^{2/3}}$$

When C is plotted against L/W_c, a different curve is obtained for every crest length.

If

$$C = \frac{Q}{L\ (h + 1.5\ \frac{V^2}{2g})^{2/3}}$$

the spread of the curves is decreased but not enough so a single curve can be drawn. Here, h is the observed head and V the mean velocity at the cross section where h is measured.

When

$$C = \frac{Q}{L\ \left[(h + 1.5\ \frac{V^2}{2g}) - H_o\right]^{3/2}}$$

a single curve is obtained for thé three narrowest crest lengths while for the 1.75-ft crest length, the curve is only about 2 percent lower and for the 2.5-ft crest length is about 6 percent lower.

Using the Francis formula for end contraction and combining it with the Fteley and Stearns formula gives

$$C = \frac{Q}{L - 0.2h\ (h + 1.5\ \frac{V^2}{2g})^{3/2}}$$

Plotting this against H/L produces a single curve, but the formula for C is not dimensionless.

Only 34 tests were made. Due to the fact that several variables are involved, no final conclusions can be drawn at this time. However, the discharge coefficient presently used by the Soil Conservation Service (3.1) is slightly lower than those obtained during the tests completed to date and, therefore, on the safe side.

Minnesota

CIRCULAR PIPE-TO-SAF STILLING BASIN TRANSITIONS TO BE STUDIED

F. W. Blaisdell, Minneapolis.--To meet a high-priority need of SCS, a new study has been initiated at St. Anthony Falls Hydraulic Laboratory. This study has a twofold purpose: (a) To analyze the data already obtained on diverging transitions in supercritical flows and attempt to put them in a form readily usable by the designer; (b) to develop a generalized design for the transition from circular pipes to the rectangular flow cross section required at the entrance to stilling basins.

Tentative plans for this study include the following:

1. Tests will be made on an outlet consisting of an abrupt change from a circular to a rectangular section, a parallel-sided length of channel to improve the depth distribution, a flaring section to spread out the flow and permit smaller stilling basins to be used, and a SAF stilling basin. The pipe will be placed on both zero and steep slopes. A parabolic floor will be used for some tests to determine its characteristics and limitations.

2. Consideration will be given to development of a transition having conical fillets between the circular section and the rectangular section to provide a smooth change in cross section.

3. Use of a hump in the transition floor to increase the rate of spread of flow will be considered. The hump may permit a reduction in the transition length and may improve the flow distribution.

4. The possibility of making the change from a circular section to a rectangular section under pressure will be investigated.

5. Attempts will be made to develop design criteria for the case of diverging straight sidewall transitions on normal slopes. Additional tests will be made only if sufficient data are not already available.

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